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ELECTRONICS ILLUSTRATED

February, 1960 Vol. 3, No. 2
A Fawcett Publication

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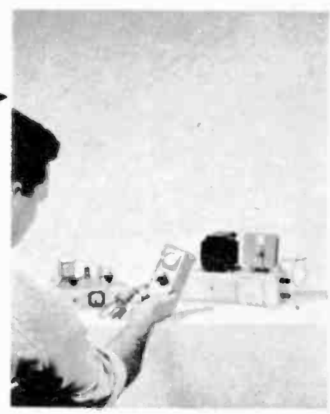

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A Message From the Editor

IT seems we have underestimated the technical knowhow of our readers. Believing that our magazine would be most popular with electronic kit builders and those who have never built any electronic device before, we intentionally de-emphasized the schematic diagrams in our construction articles and developed the unique wiring guides which have become our trademark. These guides are so easy to follow that we assumed our schematic-reading constructors would use them also. Well, we have done many of our construction fans a great injustice. We have received many letters from you asking us to make our schematics bigger and easier to read, and this we are doing promptly. As you will notice in this issue, our schematics are now larger and clearer. As some of the letters indicate, many of the complainers were those who could not read the schematics to begin with, but have learned by reading *EI* regularly. Good, this is a step in the right direction.

Not so long ago in this column I promised to bring you an article on amateur radio informational networks and I am pleased to say that it appears on page 60 in this issue. It took some doing to find the man who we think knows as much or more about this subject as anyone in hamming today, but we think we found him. If you are looking for one more good reason for becoming a ham, read this story. Two other exciting stories in this issue are: "Radio Powered Sky Station," (page 27), and "New Tiny Tape Recorders," (page 34). Our article on the sky station is the first detailed story on this epic making advance to appear in any of the electronic publications. Although the one on our cover actually appears to be flying, I must admit that it was a rigged shot since the device we photographed was a static display model. However, I can tell you that the Raytheon Company has actually demonstrated a flying model to the government, but turn to page 27 to get the full story.

Coming next month! EI's all transistor organ

We had no idea as to how many tiny battery-operated tape recorders there were available at a modest price until we started to investigate the field for our story. Most of the units in our story are imported from Japan or Europe, and if you have not seen them it is because their

importers didn't feel that a mass market existed for them. Our story may change all this.

Not long ago *EI* regular Harry Kursh did a story for us on how to patent an electronic invention. The facts he dug up proved so fascinating that he followed them up and the result is his new book called, "Inside the U.S. Patent Office," published by W. W. Norton & Co., Inc., New York City. I recommend this book very highly to anyone interested in how our patent system works, and how to obtain a patent on new ideas.

Although commercial television is not a startling new innovation to our readers, it is still a subject of great interest. You may be interested, therefore, in some recently acquired statistics relative to TV in various countries of the world. It is presently estimated that there are about 85,000,000 TV sets in use in the world today. The United States alone has about 57,000,000. U. S. viewers have available to them 550 TV broadcast stations. The rest of the world at large has 965 stations. This should give you some idea of the tremendous interference problem that would be involved if some satellite could reflect all signals from earth back down again to all sets within view.

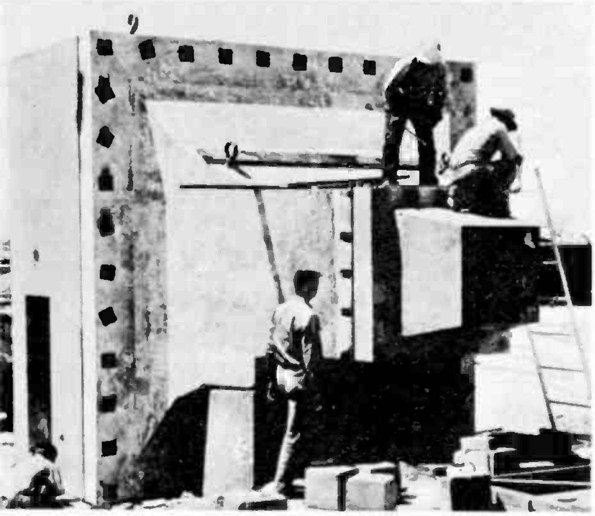
Our March issue will be jammed with many exciting construction and feature articles. Our special 16-page bonus section will show you, in clear diagrams, photos and text, how to build an *all-transistor electronic organ.* Among electronic constructors, this type of item has consistently been one of the most popular. We have tested the *EI* organ using local editorial talent and we can authoritatively say that whereas we may not have struck the right keys at all times, at least the organ knew what it was doing. We will also bring you a construction article on how to build a 2-way Citizens Band radio as well as a feature article describing the newest items for stereo hi-fi.

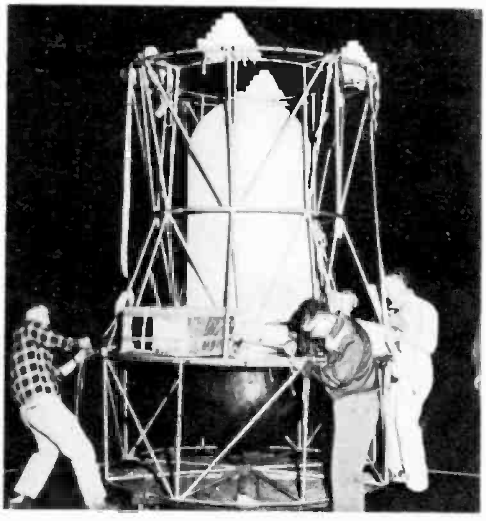
Be sure to be with us next month.

Charles Tepfer

Electronics in the news

In an attempt to learn more about radar characteristics at stratospheric altitudes, scientists at Goodyear have developed the radar unit at right to take aerial radar photos of the earth. Carried aloft by the unmanned balloon above, the radar does its job and is returned to earth by a radio controlled signal.





Audiophiles! Dig this crazy 53-ton loudspeaker horn at left. As part of an eventual 100-ton acoustical test chamber at Goodyear Aircraft Corporation, this device will be used to direct sound to plane-wave and reverberant type chambers. The chamber is to be used to study sound waves and their effect on electronic components used in supersonic aircraft.

. . . News

National Sonics Corp. has introduced a build-it-yourself electronic organ featuring two keyboards, built-in speakers, etc. A brochure giving full details is available from the manufacturer, 680 E. Taylor Ave., Sunnyvale, California.

—o—

RCA is now producing a ceramic-metal superpower tube especially designed for use in long-range search-radar and particle-accelerator service. This water-cooled tube can provide a useful peak power output of 1.5 million watts at 200 mc for a pulse duration of 2500 microseconds.

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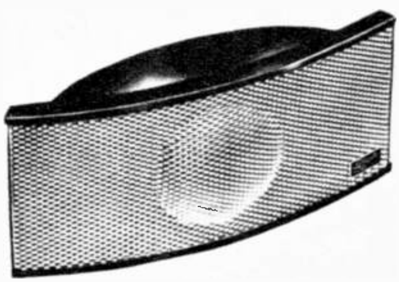
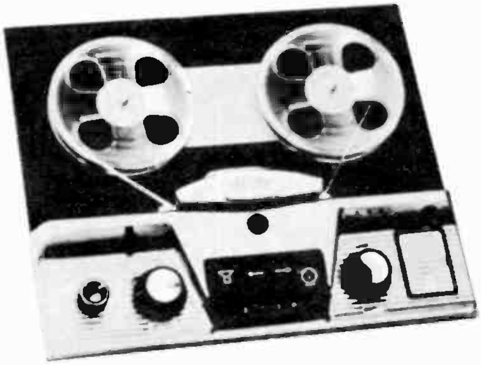


Lafayette Radio has placed the new SK-131 "Sphericon" tweeter on the hi-fi market. Priced at $19.50, it is equipped with a built-in 3000 cycle crossover network. Complete specifications available from Lafayette at 165-08 Liberty Avenue, Jamaica, N. Y.

. . . News



A stereo tape deck, the Arkay/Harting MS-5, has been introduced to the component market. Priced at $129.95, it has a dual-track magnetic tape head, for record and playback, and separate erase head coupled with an automatic interlock to prevent accidental tape wipes. Metal tape guards control vertical tape alignment. The MS-5 features 7½ and 3¾ ips speeds, recording level indicator, digital tape counter, drop-in loading, and push-button operating controls. More information is available from Arkay International, Inc., 88-06 Van Wyck Exp., Richmond Hill, N. Y.

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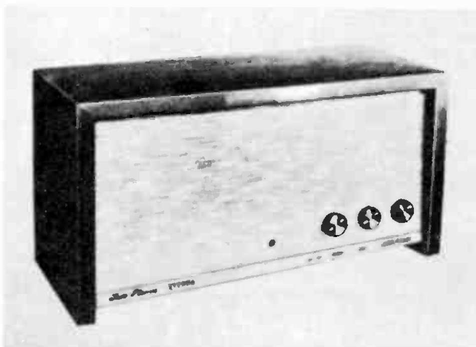

Affiliated Television Laboratories has introduced a "plug-in" stereo converter complete with stereo cartridge. It consists of an amplifier with built-in preamp, 8" bass and mid-range and 3½" tweeter speakers and crossover. The converter, SC-7, is priced at $59.95 from the manufacturer at 39 Rosell St., Mineola, N. Y.

...News

Twin AM and FM tuners, that can combine to form one stereo tuner unit, have been announced by Stromberg-Carlson. The AM-441 does not have its own power supply, but derives its power from the FM-443 when they are operated together. It is available with a power supply as the AM-442, $59.95. Separately, the FM-443 is priced at $79.95 and the AM-441 at $49.95. Combined as the SR-445 it is $129.95. They are available in gold and white, or black and chrome with covers in white, black, tan or red from Stromberg-Carlson, Rochester 3, New York.

—o—

Small enough to fit in a tube shorter than the size of a pin, a thermometer developed by scientists at Bell Telephone Laboratories can measure temperatures close to absolute zero (−459.7°F.) The thermometer employs a germanium crystal whose resistance increases rapidly as temperature falls. To find the temperature an electric current is sent through the thermometer and the resistance afforded by the germanium is measured and thus tells the temperature.

—o—

An ultra sensitive television camera that will truly see in the dark is being built by Dage Television. This transistorized TV camera will contain a sensitive "intensifier image orthicon" tube which combines the features of an image orthicon, to date the most sensitive television camera tube, with an "image intensifier" or "light amplifier." This camera is to be used by the Air Force.


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Y-737 "Ranger" Clock-Radio with "sleep" switch.. $24.95
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Y-258 4-Band "Span Master" Receiver (with cabinet). $25.95
only $2 down
R-100 Amateur Communications Receiver (Hi-gain, with built-in Q-Multiplier).. $104.50
only $5 down
Y-708 1000 Ohm/Volt Pocket Volt-Ohm-Milliammeter $9.95
Y-713 Citizen's Band, 27 mc Transceiver.......... $39.95
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. . .News

Ercona has announced the new Connoisseur, a British pickup arm equipped with a .0006 diamond stereo ceramic pickup. A knob is fitted on the 10¼" arm above the pivot point. When the knob is rotated clockwise the arm is lifted from the record. The arm is lowered by turning the knob in a counterclockwise direction. The pickup arm may be raised and lowered at any position on the record. A pivot base column allows the arm to be adjusted to fit any turntable height. Complete specs available from Ercona Corp., 16 West 46th Street, New York 36, N. Y. $59.50.

—o—

Scientists have discovered still another device to "bounce" messages off. Radio signals are now being reflected off the ionized air that is left in the wake of meteors. A message is first recorded, then a suitable meteor trail is located within a few thousandths of a second, and the message is sent at the rate of 2,400 words per minute. Tests show this 49 mc transmission is as effective as other long-range systems. Developed by the National Bureau of Standards.

—o—

New developments in solid-state electronic circuitry now make it possible to make an automatic pilot with no moving parts. Dr. A. S. Robinson, head of Bendix Aviation's Advanced Research and Development Laboratory, said "the new developments will mean the elimination of such devices as rotating shafts, gear trains, motors, etc." He predicted that the effect of these developments would be to cut in half the size, weight, power consumption, and cost of tomorrow's comparable automatic flight control systems.

. . . News

Audio Empire, the new hi-fi product division of Dyna-Empire, Inc., is entering the market with the Empire 88 "Stereo/Balance" cartridge. The Empire 88 with a .0007 diamond stylus is priced at $24.50 and the Empire 88S with .0007 sapphire stylus is $18.50. Replacement stylii are available. Audio Empire, 1075 Stewart Ave., Garden City, N. Y.

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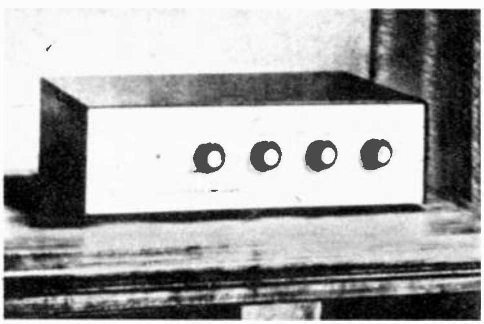

A 20-watt stereo amplifier, featuring dual 10-watt amp-preamp sections has been announced by Knight. The KN-520 contains four 7408 output tubes and features DC on preamp filaments. Priced at $62.50 from Allied Radio, 100 N. Western Avenue, Chicago 80, Illinois.

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Harold V. Jones, P.O. Box 705, Alamogordo, N. M.	1st	13
Michael F. Aperio, 916 Townsend St., Chester, Pa.	1st	12
Earl A. Stewart, 3918 Modesto Dr., San Bernardino, Calif.	1st	14
Donald L. Leeburg, Box 1075, Anchorage, Alaska	1st	12
J. Milton Condit, 1312 N. 78th Street, Seattle, Wash.	1st	8
John R. Bahrs, 72 Hazelton St., Ridgefield Park, N. J.	1st	12
Richard Baden, 4226 - 37th St., N.W., Washington, D.C.	1st	12
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. . . News

Superex Electronics Corp. has announced a new transistor radio kit, model DYN. This two transistor kit features matched transistor and diode, selective variable capacitive tuning, a loopstick, earphone, headband and comes with a black and gold case. It operates on flashlight batteries. The manufacturer says the kit can be assembled in an evening with only a screwdriver. A free catalog is offered to the readers of *EI* just by writing to Superex Electronics Corp., 4-6 Radford Place, Yonkers, New York. The price of the kit is $7.49.

—o—

Chelmsford, England sends the news that a new shortwave radio transmitter that can simultaneously broadcast two or more independent transmissions on different wavelengths was developed.

The Marconi Wireless Telegraph Company's transmitter (1 kw) enables service on one frequency to be put on a second frequency before being discontinued on the first frequency. This is possible by the use of a distributed amplifier which provides wide-band amplification over the entire high frequency band. This dispenses with the need to retune the amplifier whenever a change of frequency is desired. This amplifier also permits simultaneous radiation of two or more independent transmissions. The idea of the distributed amplifier used as a low-level voltage amplifying device is not new, however, this transmission is believed to be the first successful use in this type of service.

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. . . News

New Bulletins and Catalogs . . .

A handbook entitled "Understanding Transistors" written by *EI's* test equipment expert, Milt Kiver, is available from Allied Radio Corp., for 50¢.

The 1960 Hi-Fi Buying Guide, a catalog on hi-fi components, has been published by Harvey Radio. Available for the asking from Harvey at 103 West 43rd St., N. Y. 36, N. Y.

Bulletin SR-257 from International Rectifier Corp. describes their line of silicon zener diodes. El Segundo, Calif.

A Semi-Conductor directory listing the latest in transistors, diodes, etc. has been announced by Lafayette Radio. Manufacturers and types are listed with descriptions and applications. Free from Lafayette at 165-08 Liberty Avenue, Jamaica 88, New York.

Pentron Corporation has published a new catalog sheet giving general information on their 1960 Tape Recorders. Dept. NR-101, 777 S. Tripp Ave., Chicago 24, Ill.

R-Columbia Products Co., Inc. of 305 Waukegan Avenue, Highwood, Ill. has announced a catalog (No. 59) of professional hints for the inventor.

A bulletin, R-14, describing enclosures and cabinets for hi-fi mono and stereo has been issued by Rockford Special Furniture Co. Copy available from Rockford at 2024 23rd Avenue, Rockford, Illinois.

Full details of Seco Manufacturing Company's line of test equipment appear in that company's new brochure. Free copies of Folder M-C099 are available from Seco at 5015 Penn Avenue, South Minneapolis, Minnesota.

"The Microphone in Public Address Systems" which contains rules of microphone techniques and common microphone usage problems and solutions is available from Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, Ill.

A 32-page booklet called "Entertainment Transistors for Every Design Approach" is being offered by Sylvania. It contains ratings and characteristics for transistors for use in hi-fi, toys, etc. Free from 1100 Main St., Buffalo 9, N. Y.

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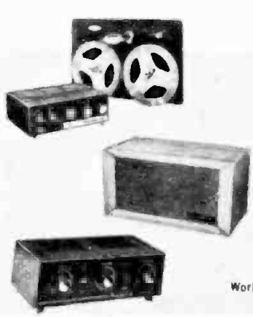
NOTE THESE OUTSTANDING SPECIFICATIONS: Power output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts, Utility. **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts.



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A kit of 15 electrolytic capacitors in five values has been made available by Pyramid Electric Co. Transistor Maintenance Assortment, Kit #515, is available for $7.70 from local radio parts distributors.

—o—

For audiophiles who like to feel the deep bass in recorded music, Electro-Voice has perfected its 30-inch loudspeaker, the model 30W. Write to manufacturer in Buchanan, Michigan for more information.

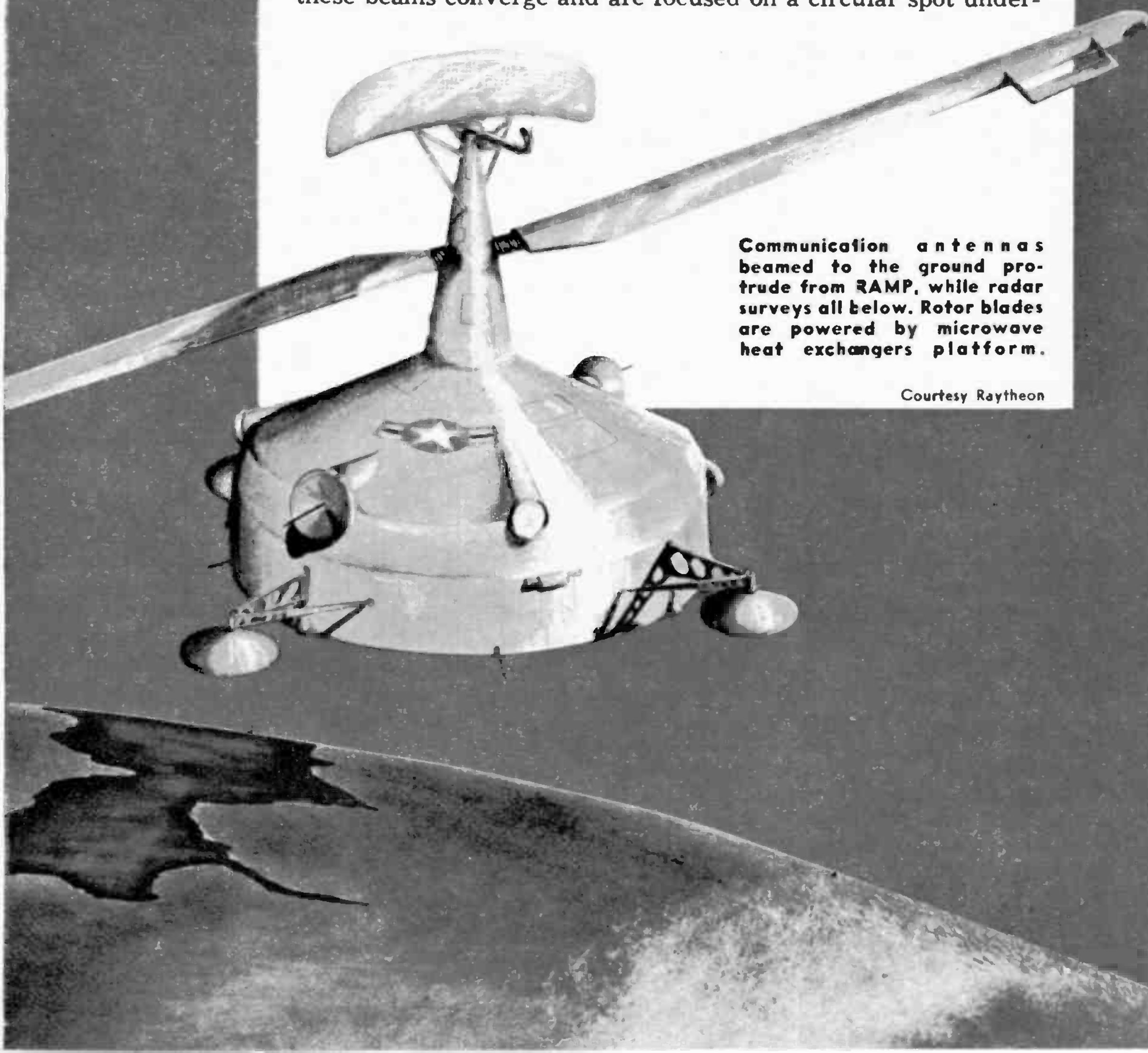
◀ See Page 24 for EICO'S BEST BUYS in "HAM" GEAR and TRANSISTOR RADIOS.

Radio-Powered Sky Station

Aloft on microwave power, sky station will provide better communications, better missile-age defense.

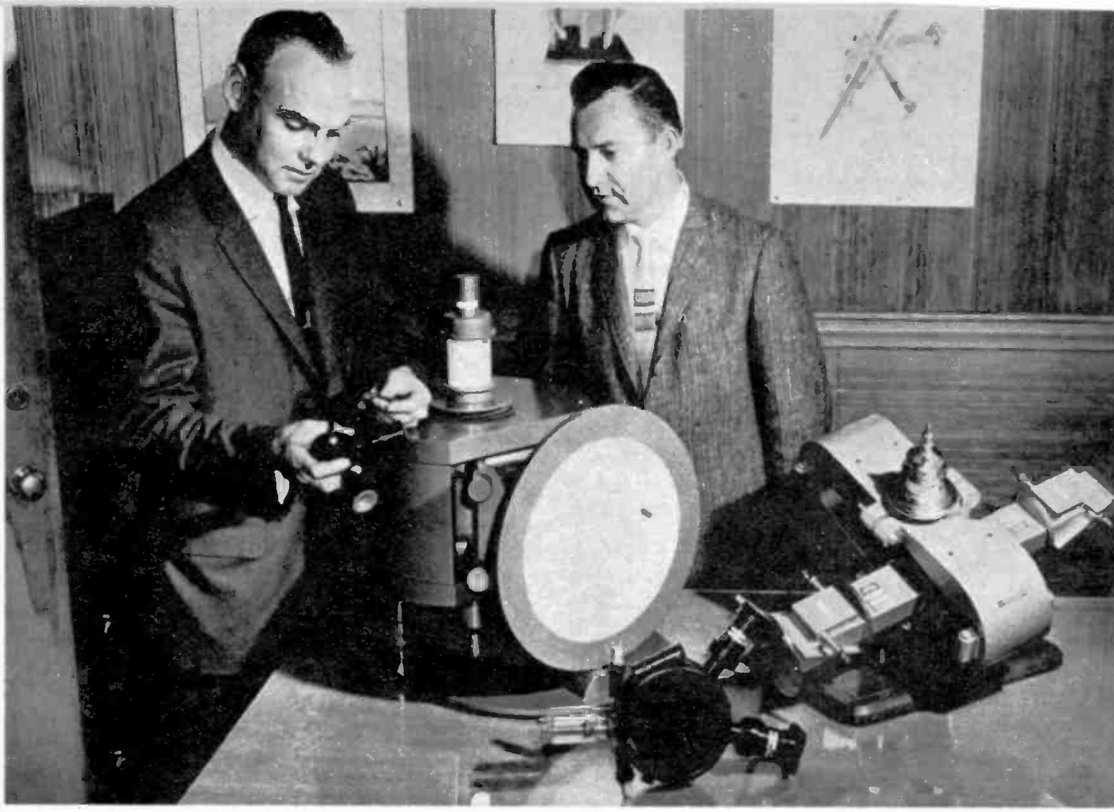
THE controlled transmission of energy through space is no longer a dream of scientists or the exclusive tool of fiction writers—it is reality.

Raytheon's Airborne Microwave Platform (RAMP) is a sky station, not an orbiting satellite, that is powered and supported aloft by microwave energy generated at a ground station and beamed to the platform by antennas grouped in a 400-foot-square antenna array. Like a battery of searchlights all operating as one, these beams converge and are focused on a circular spot under-



Communication antennas beamed to the ground protrude from RAMP, while radar surveys all below. Rotor blades are powered by microwave heat exchangers platform.

Courtesy Raytheon



New Amplitrons are designed for 50 times more power than early (hand-held) unit.

neath the sky station, which is about 50 feet in diameter.

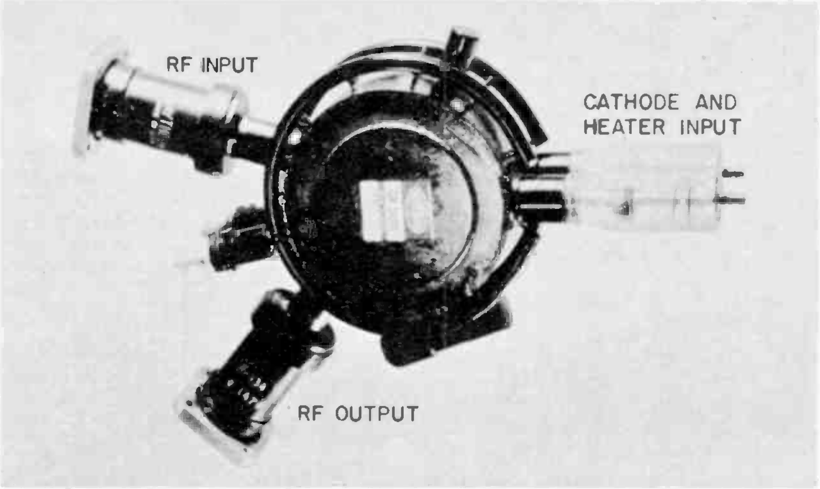
Why a sky station? The projected military and commercial capabilities are tremendous. RAMP is designed to raise itself 65,000 feet above the earth and become a highly stable "stationary" platform far above the weather. The curvature of the earth will not matter at that height.

To the average man, this would mean that he could watch the Folies Bergere from Paris, the Olympics from Europe, and other world events on his TV set as they happen. It would also mean that business and personal telephone calls and telegrams to distant points could be made at a fraction of the present rate.

A system of such platforms would act as a long-range missile alarm, guide defense vehicles (such as Bomarc anti-missile missiles), and reliably relay broadband communications and weather surveillance data to stations on the ground. The entire North Atlantic can be covered with only four such platforms. This amounts to an extension of the DEW Line all the way to Europe.

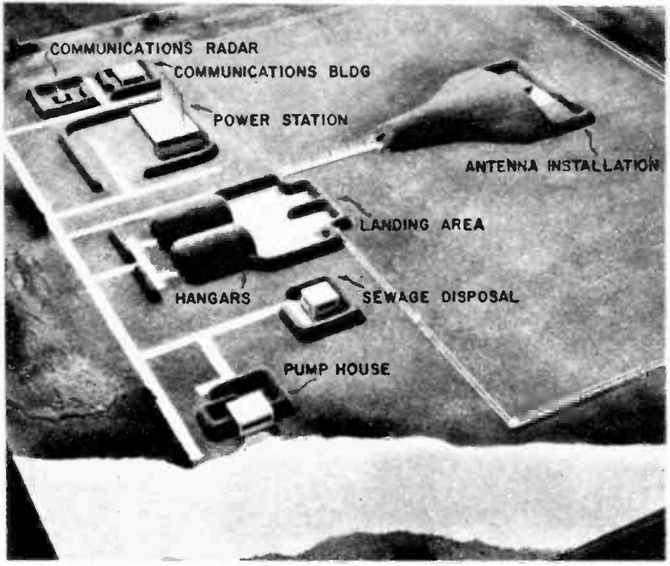
Until recently, tubes with high enough power to keep a sky station aloft were available only at relatively low microwave frequencies. Low frequencies meant antenna arrays covering many acres would be needed to focus the microwaves on a high altitude sky station. The new Amplitron tubes now can provide power at much higher frequencies and they have the stability required to ensure an efficient, highly directional antenna pattern. This means that antennas can be brought down to reasonable size.

The Amplitron is the key to the entire project. A high-efficiency microwave amplifier tube developed by Raytheon, it can increase the microwave energy generated by the older magnetron many times. Under security wraps for many months the Amplitron's effectiveness has been proved in the "Flight-Tracker" air traffic control system and other long-range radar systems. The heat dissipation problem has always placed severe limitations on the design of high-power

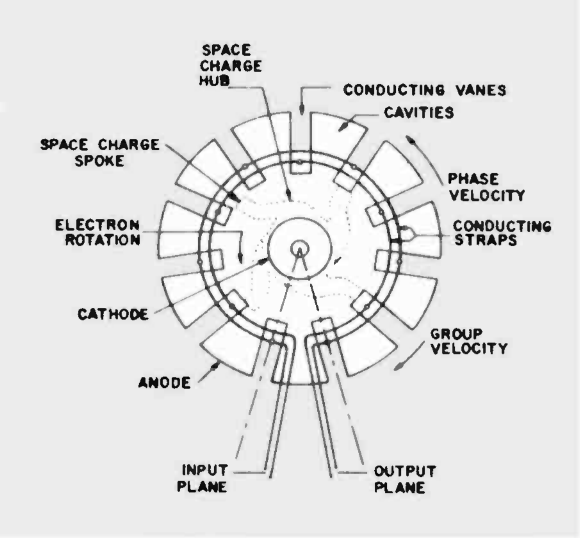


Amplitron tubes are able to efficiently amplify RF energy to a degree never before achieved. It is capable of operating in the higher microwave frequencies.

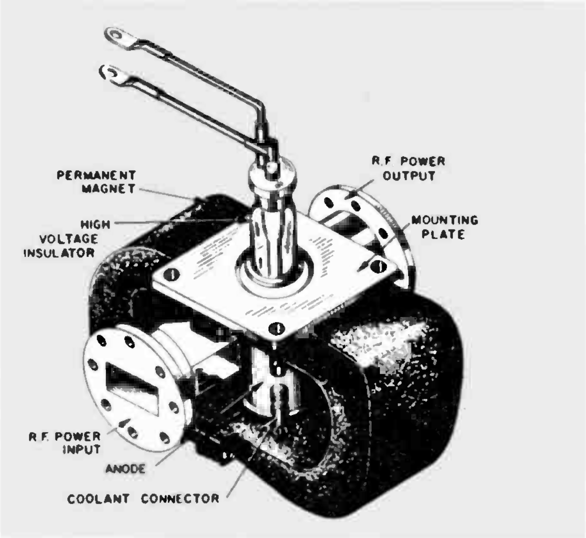
High military brass engaged in directing advanced research and development, get the low-down on model of sky station from Raytheon vice president.



Typical power-beaming ground installation has been constructed in model form. Higher frequency capabilities of new Amplitrons permit smaller antenna arrays, good efficiency.



Here is a diagram of the Amplitron's internal structure. It uses a continuous, cylindrical cathode to produce a rotating space charge in interaction space between cathode, vane tips.



External construction of typical Amplitron bears striking resemblance to that of a conventional magnetron oscillator. Size and weight are also comparable to magnetrons.

tubes, but the improved Amplitron can now handle many kilowatts thanks to new forced water cooling technology. Three-thousand megacycle tubes of 20 horsepower output are in production and units of 100 horsepower will be available shortly. Five hundred horsepower tubes are expected to be available in the foreseeable future.

The RAMP sky station has a projected 50-foot diameter (dictated by the antenna size on the underside), with a rotary wing 170 feet from tip to tip.

The circular collection antenna array on the underside is designed to pick up the microwave energy beamed from the ground and conduct it through waveguides to "lossy" elements, which convert microwaves to heat in much the same manner that a stove element converts electricity to heat. Compressed air or gas heated by the lossy elements will drive a heat engine while turbines operate the rotor blades keeping the platform aloft and supplying the power

[*Continued on page* 127]

Unit is shown atop woofer cabinet. Pair of wires go to the speaker terminals on amplifier.

Tweeter Globe

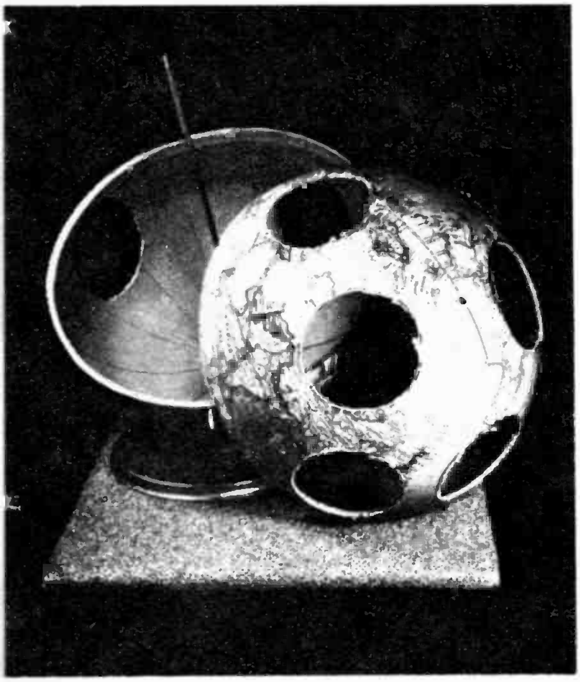
By Steven Hahn

This novel addition to your hi-fi system will overcome the problem of high frequency distribution.

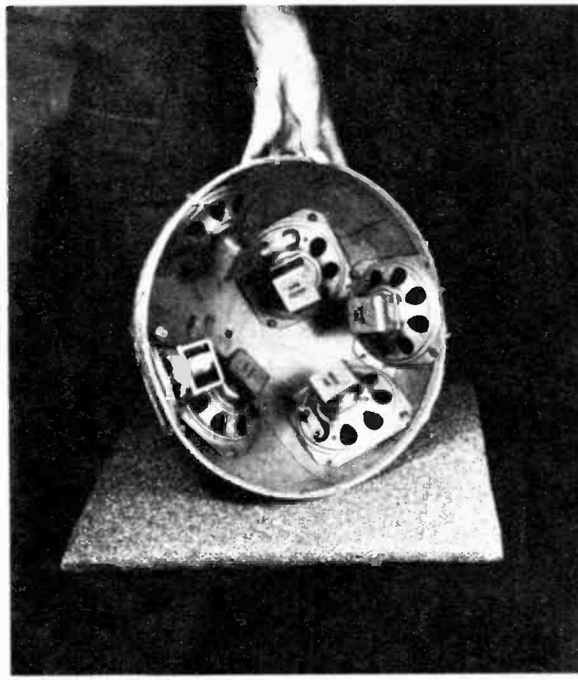
Once the number of speakers is decided upon, a compass is used to mark off holes. These holes should be random, not evenly spaced, for minimum interaction between cones. Right photo shows holes being cut with sabre saw.

ONE problem in high fidelity reproduction is the distribution of high frequency sounds. In the low frequency range, this is a minor problem because of the comparatively large size of the speaker radiating element and the distribution patterns of the sound waves. However, as one increases the frequency, the waves begin to take on more and more the characteristics of light beams; that is, they are comparatively narrow and have a tendency to

Globe is cut along its equator line with saw after all the speakers holes have been cut.



Speakers are mounted after their flanges are bent to conform to curvature of the globe.



reflect from various surfaces. The problem is increased by the fact that most high frequency radiators, whether they be horns or tweeters, have a comparatively small radiating surface. If only one of these devices is used to reproduce the high frequencies, a virtual high frequency beam results and if one moves out of this beam, a severe drop in the high frequency response is noted.

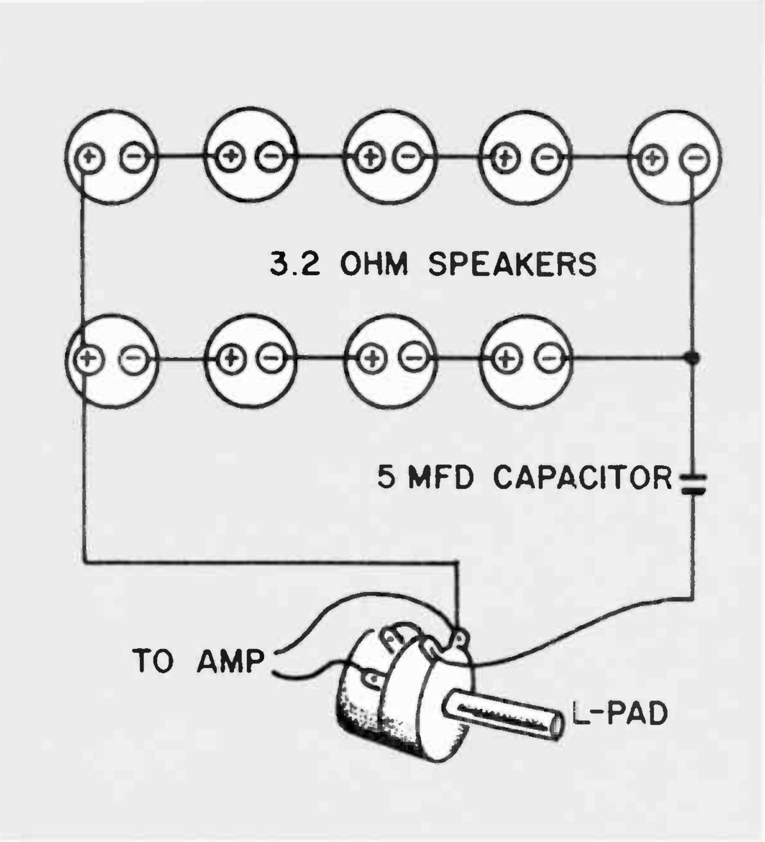
The unit which we have built here can be considered a point source of high frequency sound with even high frequency distribution patterns over the entire listening area. It consists of nine 4" hard cone tweeters mounted in random positions in a 12" cardboard ball. An L-pad is added for volume control and a 5 mfd oil capacitor serves as a dividing network. The entire unit, tweeters and all, costs about $35 to build.

Construction

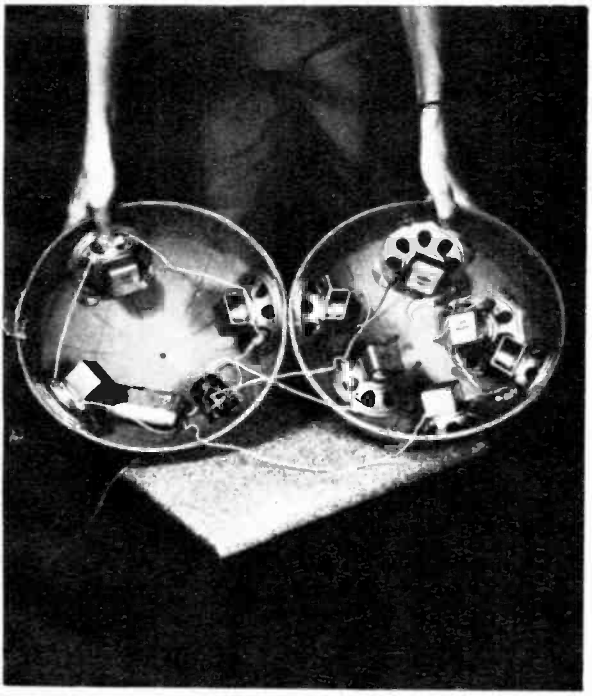
The ball in this radiator is actually a cheap 12" cardboard globe, available from many department stores. The first step is to lay out the tweeter openings on the surface of the cardboard globe. This is done with a compass. After marking the opening, a 3/8" drill is used to drill a hole in the center of each speaker opening. An electric sabre saw with a fine tooth metal cutting blade is then used to cut out the openings. All this work is done with the globe fully assembled on its stand. The tweeter openings can also be cut out with a very sharp razor or modelling knife. In addition to the nine cutouts, a 3/8" hole is drilled near the bottom of the globe to accommodate the L-pad and a smaller hole to take the speaker cable. After this work has been done, the globe is cut in half along the equator.

The flange mounting holes for the tweeters are then laid out by placing the tweeters on the inside of the two globe halves and using a pencil to mark the mounting holes. Generally speaking, speakers of this size require four mounting holes; however, two will more than suffice in this instance. An important

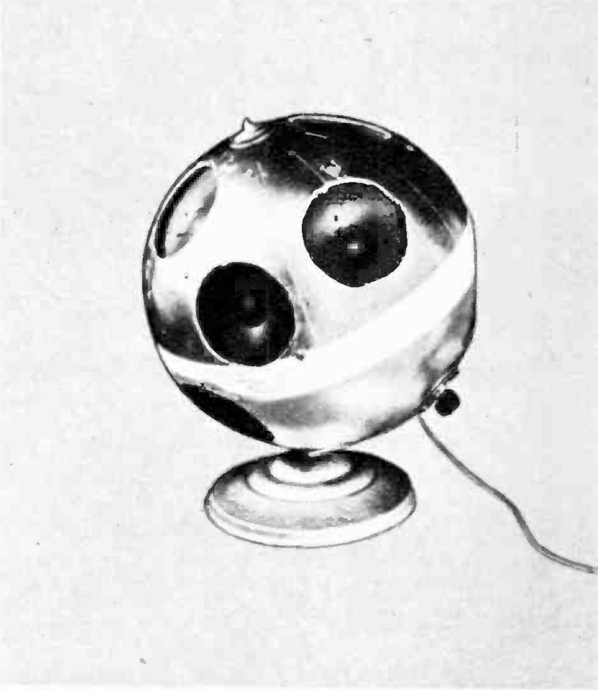
[*Continued on page* 121]



Speakers are connected in series-parallel and controlled by 8-ohm L-pad, as shown.



Wiring complete. 5 mfd capacitor is at bottom of globe's left half. L-pad is next to it.



Two halves are held together by tape. Globe may now be finished with a coat of paint.

EI Exclusive

British-made "Fi-Cord," with rechargeable batteries, records at 7½ ips and has a more expensive Swiss "near-twin" in "Stellavox."

New Tiny Tape Recorders

Once there were none, now there are many battery-powered tape recorders at a variety of prices.

So new it doesn't yet have a price tag—that's this Nippon Sound "Transicorder." It operates on AC or battery, has meter, 2 speeds, remote switch.

Four conventional flashlight batteries run the Mark III Phonotrix tape recorder with speaker.

Not yet available in this country is the Japanese Kowa, which is a 9-volt unit, 3¾ ips only.

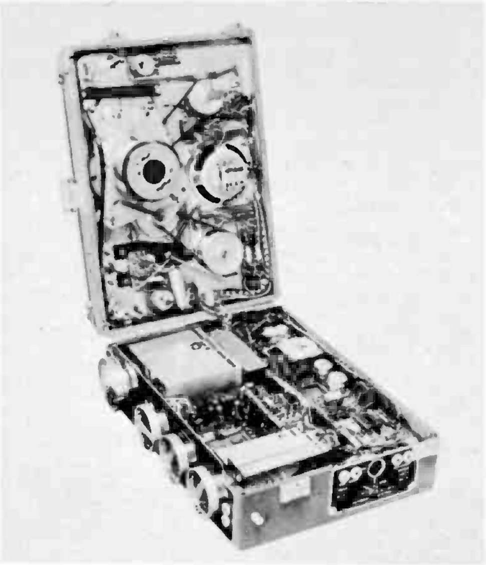
Stuzzi comes from Austria and records on two speeds. Push-button controls are on the top.

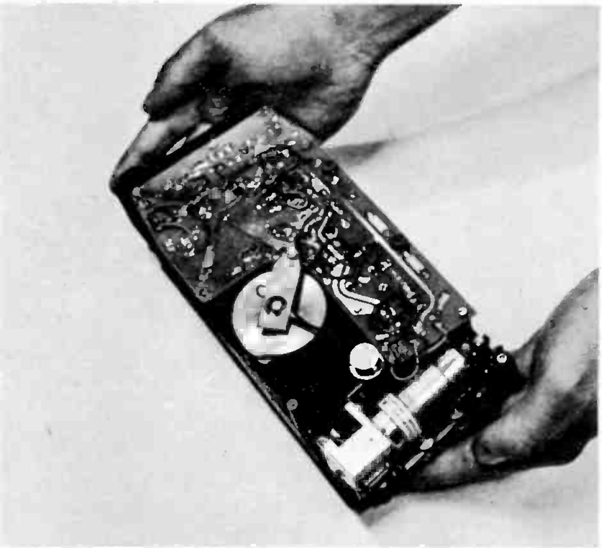
Here's the "Hi-Delity" 401B machine from Japan at $159.50. Single lever controls all.

ABOUT five years ago you would have had to look mighty hard to find a small, battery-operated tape recorder. Chances are that if you had wanted one badly enough, you would have had it especially made for you at a fancy figure. Today, however, all that is changed. Whether you be in America, Europe, or Asia, you can take your pick of many transistorized recorders—and there are more coming all the time!

The battery-operated tape recorders we've seen range from "gimmick" machines that sell for under $30, to professional broadcast quality three-speed instruments that carry price tags close to $1000. While some of these small machines operate only at the 1⅞ ips speed, other more sophisticated units zip the tape along as fast as 15 ips. Many have a myriad of specially designed accessories that include such items as magnetic telephone pickup coils, extension speakers and remote control switches, while still others don't even have an electrical fast rewind.

Electronics Illustrated's survey of this new and exciting field





Upper left: The circuitry of the deluxe Nagra III, a Swiss-made instrument with thirty transistors, three speeds to 15 ips.

Above is the same unit put back together. There are several input and output sockets and a meter located on panel.

Photo at left shows how the bottom of the S330 "Fi-Cord" looks. All battery-operated machines use printed circuits.

has turned up some very interesting tape recorders, along with the dismaying fact that American companies seem to be avoiding the manufacture of general purpose units, leaving this field almost exclusively (but not quite) in the hands of makers in Japan, West Germany, Switzerland and Austria.

What have the American manufacturers been doing? Twiddling their thumbs? Well, evidently some have, but not all. A few have been working out miniature models for inclusion in guided missile and space rocket systems. Perhaps we'll hear more about them when present-day military electronic developments finally filter down to you and me on the consumer level.

Other U. S. companies have concentrated on making miniature tape recorders primarily designed for dictation. Among them are units by Dictaphone, Comptometer, Peirce, etc. Of course, these may be used for on-the-spot recording other than dictation, however they usually feature elaborate (hence more expensive) start-stop mechanisms and generally record only at the slowest speed, 1⅞ ips.

Let's take a look at some of the battery-operated general purpose tape recorders that can be used anywhere.

The Grundig "Niki" lists for only $79.95 and is made by one of West Germany's leading electronics manufacturers. It is one of the few portables we've seen that has a plastic case, which tends to cut down on its weight (4½ pounds). It operates on ordinary "D" flashlight batteries and its fidelity is more than adequate for voice reproduction. Just like most small tape recorders, this one records in the half-track fashion and only at 3¾ ips. The tape, on standard three-inch reels, does not have to be threaded through any intricate capstan system, but is simply dropped "into the slot." The machine we tested had very good positive action controls. A single knob handles the start, stop, record-playback and fast rewind functions. The built-in four-transistor amplifier draws little current from the batteries, which can last as long as 50 hours. Batteries, printed circuit, motor, etc., are all easily accessible for servicing. Distributor: North American Industries, 101 W. 31st Street, New York 1, N. Y.

There are a couple of miniature tape recorders on the way that are shrouded in all the legendary "mystery of the Orient." How come mysterious? Well, we have seen and tested them, but for the life of us we cannot get anyone to quote prices at this writing. Both units are from Japan and one is the recorder pictured on this month's cover. It is the Yashica YTR-330, which will be marketed here by the famous camera company. Also using three-inch reels and half-track recording head, this portable is designed to operate at 6 volts and the convenient 3¾ ips. Besides a built-in

[*Continued on page* 114]

The low-priced ($79.95) Grundig Niki has its innards exposed in picture top left. Circuit is accessible for servicing.

Above right is the same tape recorder. To thread tape from three inch reels you just drop it into slot above stop button.

Mohawk Business Machines makes this tiny pocket tape recorder which actually has twins under other trade names.

E I Reviews the Ham Bands

spotlight on:

40-Meters

By C. M. Stanbury II

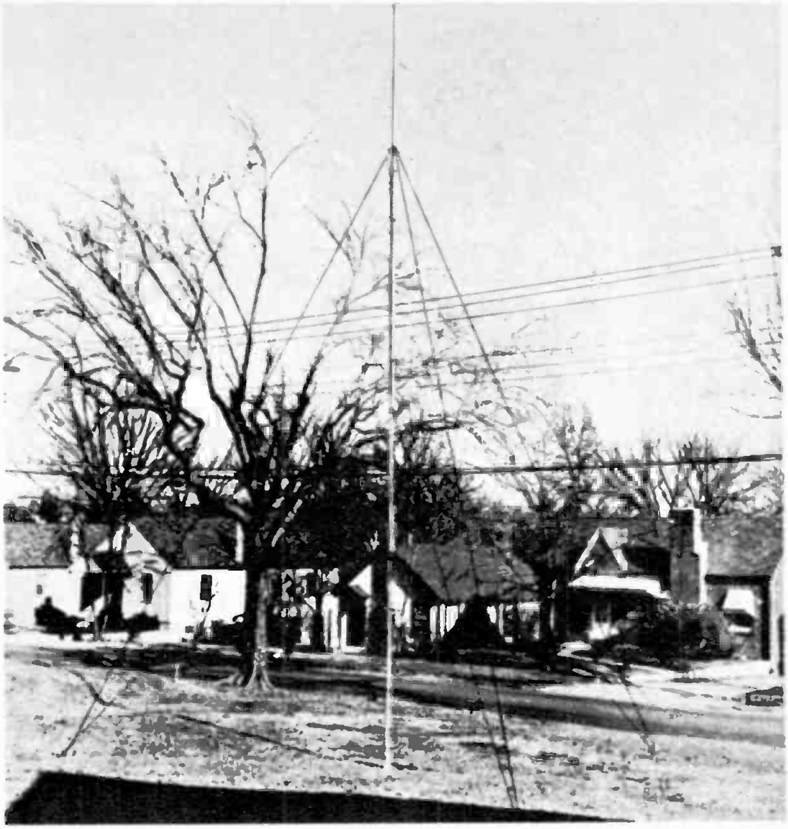
This article, second in a series, covers 7 to 7.3 megacycles—what's on the band and how hams and SWL's can help free the band from Red propaganda.

THOSE frequencies between 7000 and 7300 kc comprise the most complex band anywhere in the radio spectrum. Its uses are myriad. Historically, 40 meter channels are used by both broadcaster and amateur; have started an international donnybrook; and have been open territory in the Cold War.

The experienced ham uses the 40 meter band for rag chewing, for regional and national message networks, and also has found plenty of DX in these midlands. Almost more important, it's one of the best bands for the Novice. Does this sound like an active band to you? . . . Well, you're right! Why?

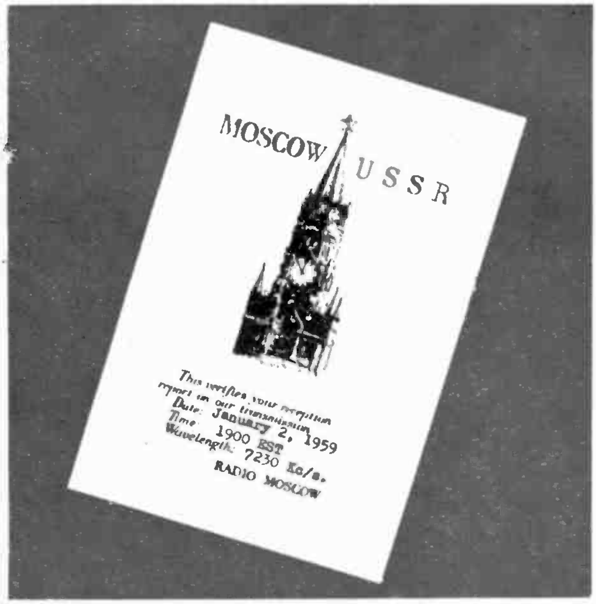
In the first article of this series we mentioned that 75 and 80 meters were just above the dividing line between short and medium wave. Forty meters is also near a dividing line—the one between regional and international shortwave. It lies at about 7 mc, depending upon sunspot activity, season of the year and even day-to-day variations of ionospheric density. Ionospheric absorption of the 40 meter signals can be very high or close to nil. Skip distances during daylight hours can be so short as to almost permit semi-local QSO's via skywave. But at night, under ideal DX conditions, they can be so long as to allow only transcontinental contacts.

In other words, the day-night pattern of 75 and 80 meters is repeated here, but in much more generous proportions. While the sun is high, maximum range is somewhere around 500 miles, but this increases perceptibly toward sunset and even more rapidly during the hours of darkness. With a decreased noise level and the longer period of darkness, a winter night is obviously the peak period for 40 meters. And with all of these variations, it is obvious that not only is anything possible, but

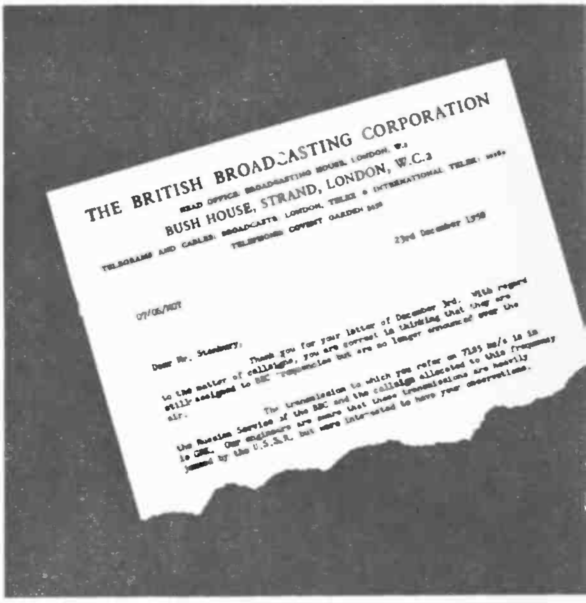


Here's a commercial vertical antenna (Mosely V-5) designed to work on 10-80 meter bands. For homemade 40 meter antennas, turn page.

Reds love to QSL propaganda broadcasts. Note frequency—smack in middle of U.S. ham band.



This letter from the BBC confirms two types of interference experienced on the 40 meter band.



also, everything should be expected.

The 40 meter band is 200 kc smaller than the 75-80 meter allocation, and the 'phone portion of the band is only half the size of 75 meters. (Here both the CW and 'phone portions of the band go by the same name.) While increased skipping tends to reduce QRM (man-made interference), reduction in space cancels this out. There are very few clear channels available for 'phone.

Forty meters is traditionally a CW (radio-telegraph) band. It has only been within the last ten years that the FCC has permitted any voice transmissions on the band at all, and because of these crowded conditions for voice between 7200-7300 kc, CW still remains the most effective means of communication, especially for DX.

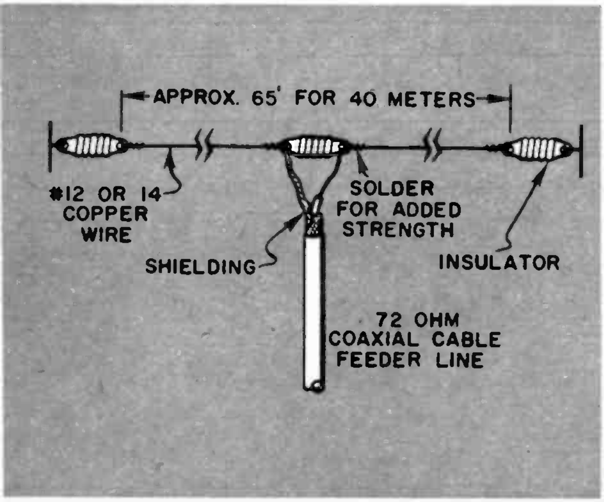
Many hams overseas are permitted to use only the lowest 100 kc of the band and 75 percent of these are limited entirely to CW. Hams in the United States wishing to work them generally have to use CW also.

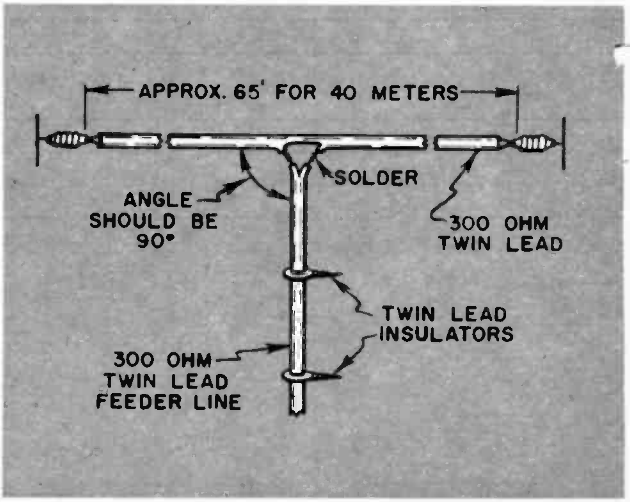
With half the wavelength of 80 meters, it is possible, but not likely that some antenna directionality can be achieved. Sixty-five feet of wire is still a heck of a lot to "rotate." Obviously, with a better antenna, the less powerful and less expensive transmitter becomes more effective. (See diagrams.)

We said 40 meters was a good band for the Novice, and so it is. Limited to 75 watts transmitter input, he can use the great variation in skip and range of 40 meters to his advantage. During the course of most days, a Novice is able, propagation-wise, to work contacts in every part of the United States. And unlike higher frequency bands, 40 meters is almost never completely dead. Even at 0300 EST an East Coast amateur would be able to QSO with operators on the Pacific Coast, where it is only midnight. Should a Far Western Novice wish a QSO at 0300 PST, he would find that it was 0600 along the Atlantic Seaboard and a number of early bird amateurs will have returned to the band.

In 1947 the International Telecommunications Union (ITU) divided the 40 meter band between amateur and broadcast stations. Seven to 7.1 mc is allocated to hams throughout the world. In Europe and Asia, 7.1 to 7.3 mc was proclaimed broadcast territory, while in the Americas the remainder of 40 meters was turned over to the amateur. As you can see, this was a regional solution and as 40 meters is frequently *not* a regional band, such a compromise was far from perfect. For example, many broadcast stations, although beamed into broadcast territory, are received in this hemisphere. Further, when such a station is jammed, the interference is still worse.

Undoubtedly the ITU took all this into account when it set up the dividing





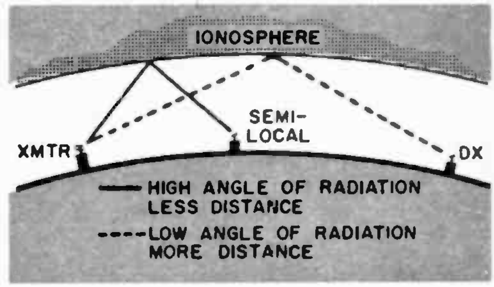
lines and almost all concerned thought they had made the best of a difficult situation. But they did *not* figure on Radio Moscow taking advantage of the situation.

What Moscow has done is to beam 40 meter transmitters toward the United States. At certain winter hours they use no less than five outlets with a total power of approximately half a million watts! Each puts out in the neighborhood of 100,000 watts (a hundred times the maximum power permitted for amateur use). With this system the Kremlin holds down at least one channel, often two or three. If this does not violate the letter of the agreement, it is certainly contrary to its spirit.

With a dropping sunspot count and the resultant increase of low frequency range, this situation is going to get worse. Radio Prague (in Red Czechoslovakia) has added another 100 kw to the assault and there may be more.

There is little that can be done about such stations as GRK. The operating agency, in this case the BBC, is sticking to the ITU agreement and any interference caused by them is accidental.

The propaganda broadcasts are in a different category. First, you must understand that Moscow has no special desire to give the ham a hard time. There would be no point in it, and the Kremlin never does anything without a reason. The use of 40 meters simply increases their propaganda coverage. If it didn't, they would stay off the band.

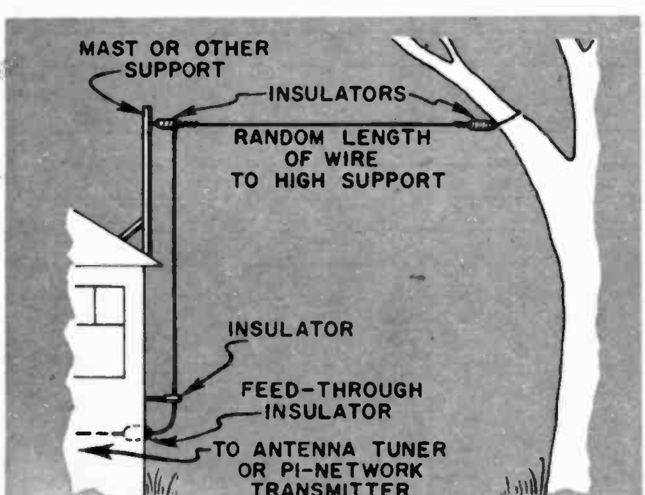


An antenna on 40 meters should be at least a half wavelength above the ground so that the low angle of radiation will not be attenuated.

Okay, why not fix things so it *doesn't* increase their coverage!

EI's plan consists of two parts. First and most important, amateurs when making semi-local (short skip) or other cinch contacts on 40 meters should use the propaganda channels, 7130, 7150, 7180, 7230, 7240 and 7255 kc. His QSO will be unaffected, but the Red broadcasts will certainly be wrecked.

The second step is in the hands of the SWL's, particularly those who listen in on the amateur bands. They should send a reception report to Radio Moscow stressing the interference on 40 meters. This way the Kremlin will be sure to know their transmissions are not getting through.



A simple, efficient 40 meter antenna is the half-wave dipole, far left. If you can't run it 65', up to 13' from each end may droop down.

In center panel we have the popular folded dipole, similar to the plain dipole, but using 300 ohm twin lead feeder instead of 72 ohm co-ax.

Most basic antenna is the long wire, right. It is tuned electrically to compensate for random wire, which must be matched to half wave.

SWL Antenna Tuner

By Don A. Smith

Improve the reception of your short-wave receiver with this unit. It will peak up those weak stations.

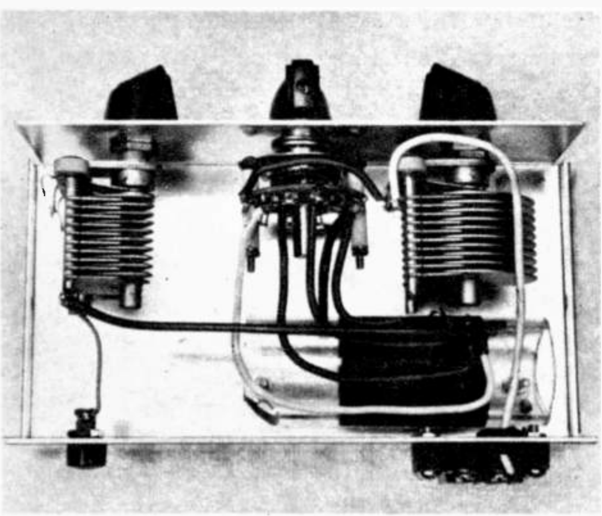
MANY short-wave listeners are forced, through lack of space, to use short antennas. Undesirably short lengths of ten to twenty feet seem to be common. To make matters worse, many receivers do not come equipped with an antenna trimmer adjustment to peak up the signals.

The unit described here goes a long way toward correcting this condition and requires no internal connection to the set. The circuit is a simple pi-network, used quite often in the output stage of ham transmitters. Its ability to *electrically* change the length of a physically short wire makes it an excellent adjunct to a receiver.

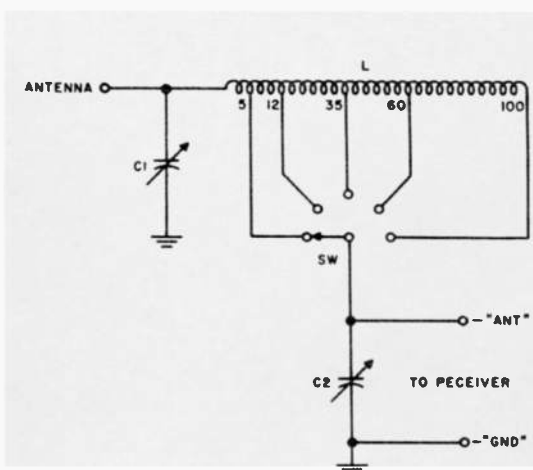
Construction begins by winding the coil. Follow the specifications given in the parts list. The total length of the winding will take up approximately 1⅝" on the form. Drill two small holes near the beginning of the coil and two more at the end. The wire can then be threaded through these holes [*Continued on page* 119]

PARTS LIST

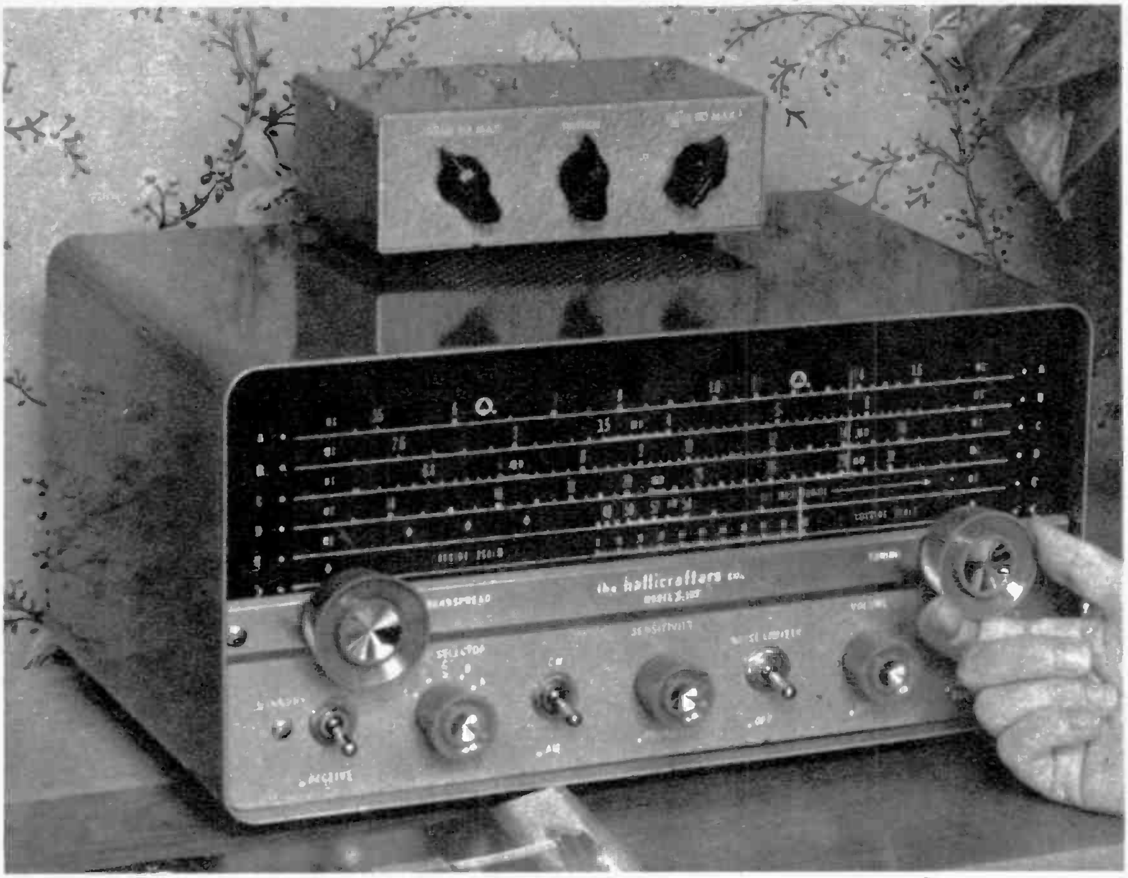
C1,C2—140 mmfd variable air capacitor
SW—5-position rotary switch, non-shorting (Centralab PA 1002 or equiv.)
L—Close-wound coil, 100 turns of #26 enamel wire tapped at 5, 12, 35 and 60 turns. 1¼" diameter coil form of plastic, Bakelite, etc., approx. 3½" long
Misc.—Chassis box (LMB #138), 2-lug Cinch-Jones Barrier strip, banana plug and jack



Inside view of the tuner with cover removed. Two tuning capacitors are along top edge with switch between them. Coil is at lower right.

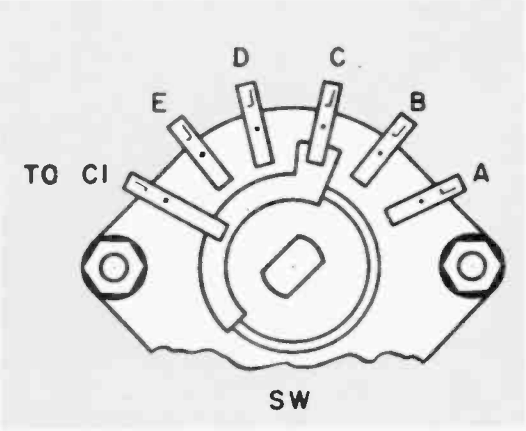


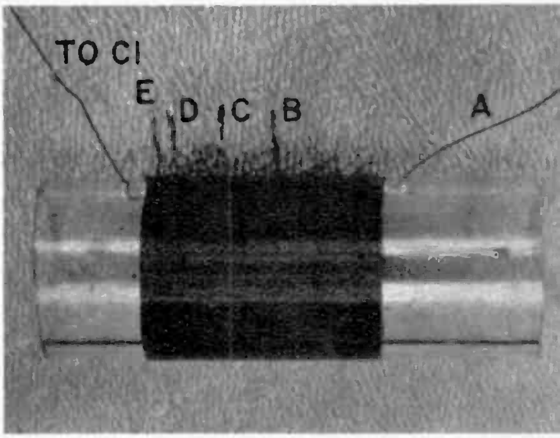
Schematic indicates the location in turns of each tap on the coil. "Ant" and "Gnd" go to a 2-terminal barrier strip at rear of unit.



To use model, connect a banana jack to the antenna wire and plug into tuner. Run a short shielded wire from tuner's output terminals to the receiver. Vary switch and tuning capacitors for best signal strength.

Switch layout is below left. Letters indicate the coil lead connections in photo at right. Letter "E" corresponds to 5th turn on coil, the first tap.





Unit is between tripod legs with two photofloods plugged into it. Photographer presses solenoid button which will turn up floods and release shutter.

Flash your Photofloods

By W. F. Gephart

Pose a subject in dim light for natural expression. This unit eliminates the glare of photofloods.

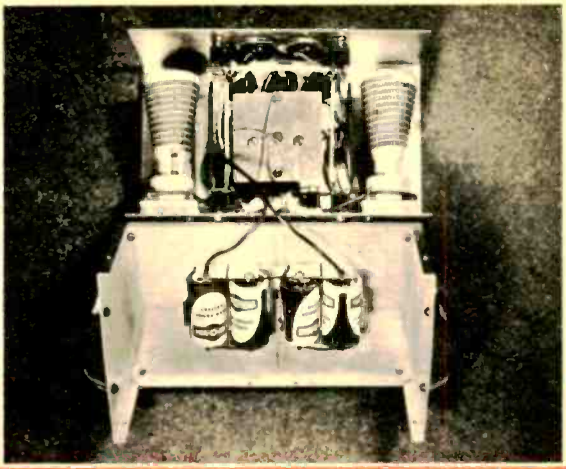
PHOTOFLOODS offer a number of advantages over flash in many cases, but have a definite disadvantage in portrait work because the bright light prevents a natural expression. This is particularly true when several lamps are used for balancing.

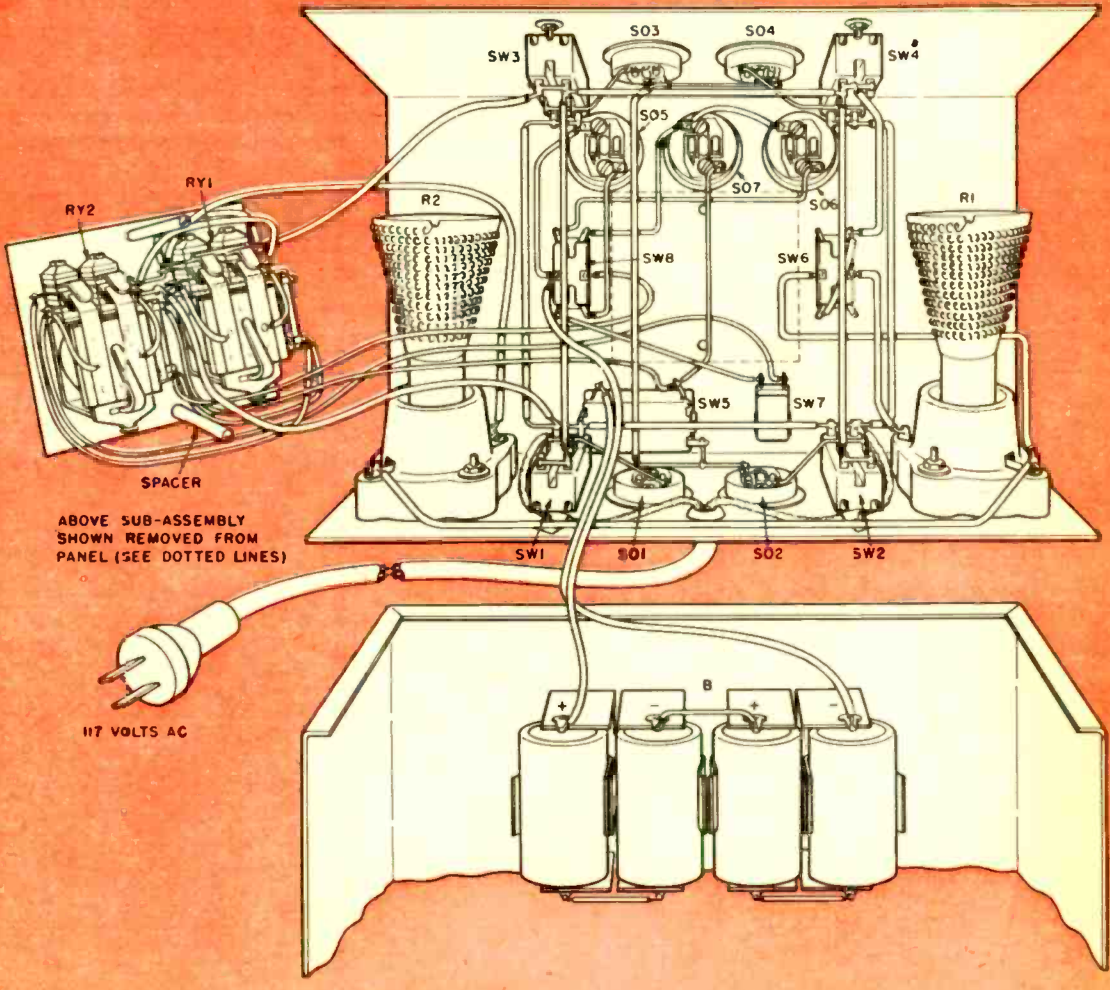
It would be highly desirable if the bulbs could be synchronized with the shutter like flash bulbs, and the exposure made before the subject could react to the brightness.

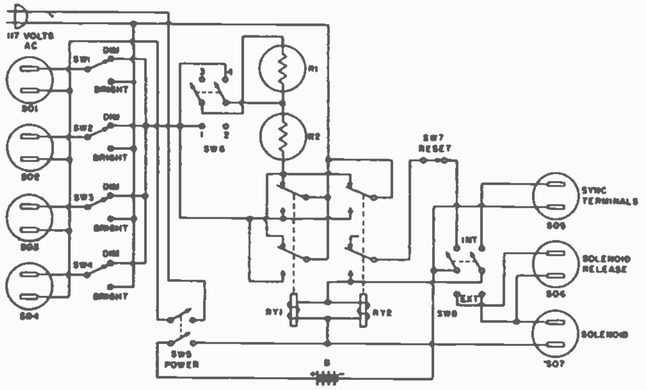
The unit shown here handles the high currents and is designed to be used with both solenoids (operated by a battery in this unit), and synchronizing shutters, such as an "M" type, set for a 20 millisecond delay. It can also be used with a zero delay ("X") synchronized shutter if exposure compensation is made.

While it takes substantial time for a flood bulb to reach maximum brilliance from the cold or "off" condition, this time is drastically reduced if the filament is well-heated, as it is when oper-

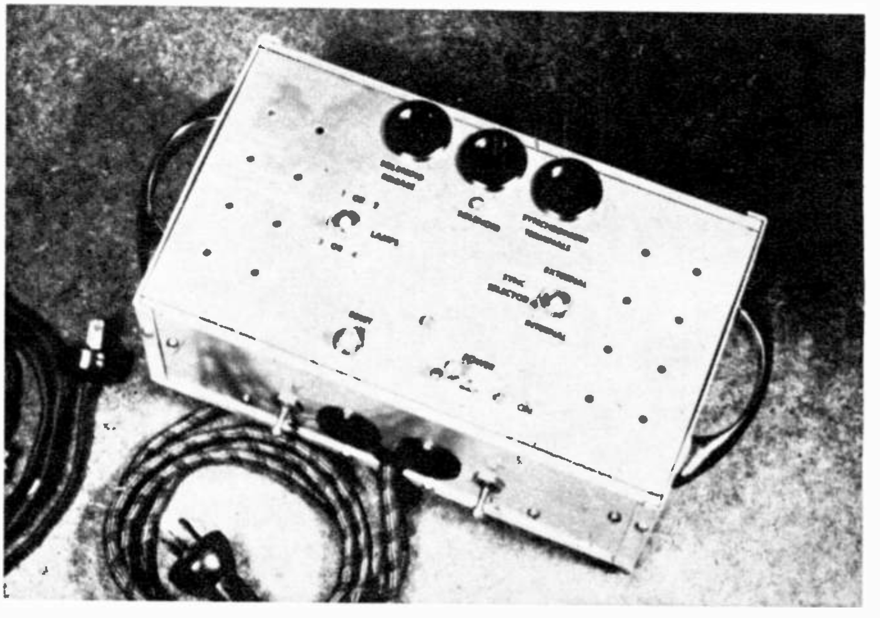
Note square panel located in upper half of case (between two heater elements). It is shown removed in guide below.







In right of schematic; sync terminals receive cable from camera shutter, solenoid release from pushbutton on cable.



Holes on both ends of front panel provide ventilation for heater elements inside case.

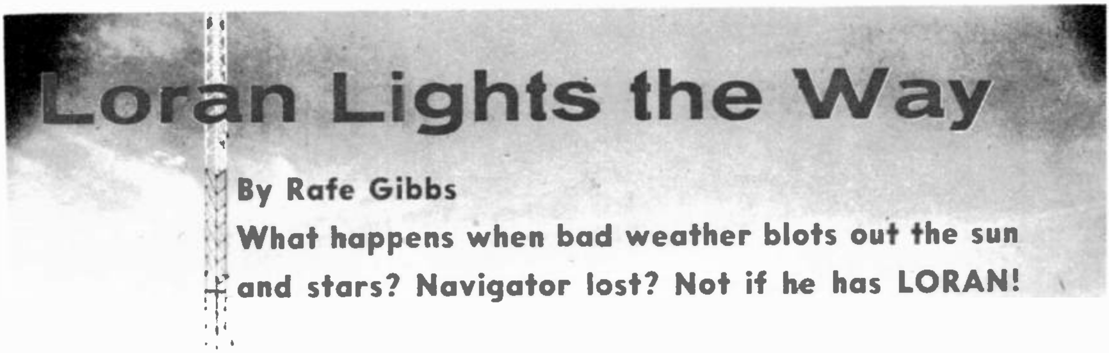
ating under lowered voltage. When a Number 1 photoflood is glowing to an extent equal to about a 25 watt bulb, it will reach full brilliance in about 5 milliseconds after full voltage goes on.

Since the shutter contacts cannot handle the high current used by photofloods, the actual switching is done by relays, which also involves a delay. It takes about 5 milliseconds for the relay to close after the voltage is applied. In this unit therefore, the photofloods will reach full brilliance about 10 milliseconds after the synchronizer contacts

[*Continued on page* 116]

PARTS LIST

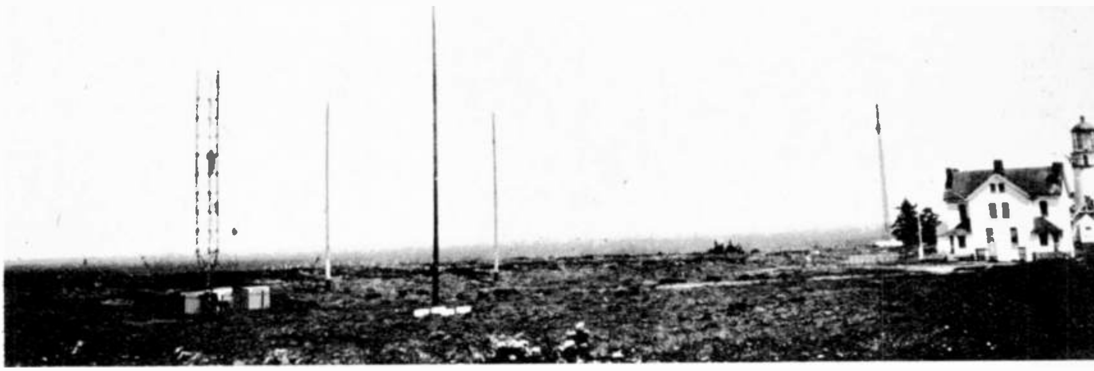
SO1 through SO7—Chassis-mount female socket (Amphenol 61-F)
SW1 through SW4—DPDT toggle switch 15 amp, contacts in parallel
SW5—DPST toggle switch 20 amp
SW6—DPDT toggle switch 6 amp
SW7—SPST pushbutton switch normally closed (Carling 170)
SW8—DPDT toggle switch 3 amp (Carling 316-73)
RY1, RY2—DPDT relay, 6 volt DC coil, 12 amp contacts. (Guardian Series 200 coil with Type 200-4 contacts)
R1,R2—600 watt Edison base heater elements
B—6 volt battery (four "D" cells in series)
Misc.—Metal case 10"x6"x3½" (Bud CU-3010), two porcelain Edison sockets, asbestos line cord, two dual battery clips, 3"x3" metal plate for mounting RY1,RY2 (used with two 1¾" screws and two 1½" spacers), Solenoid push-button release switch mounted on cable (Switchcraft E-913)



Loran Lights the Way

By Rafe Gibbs

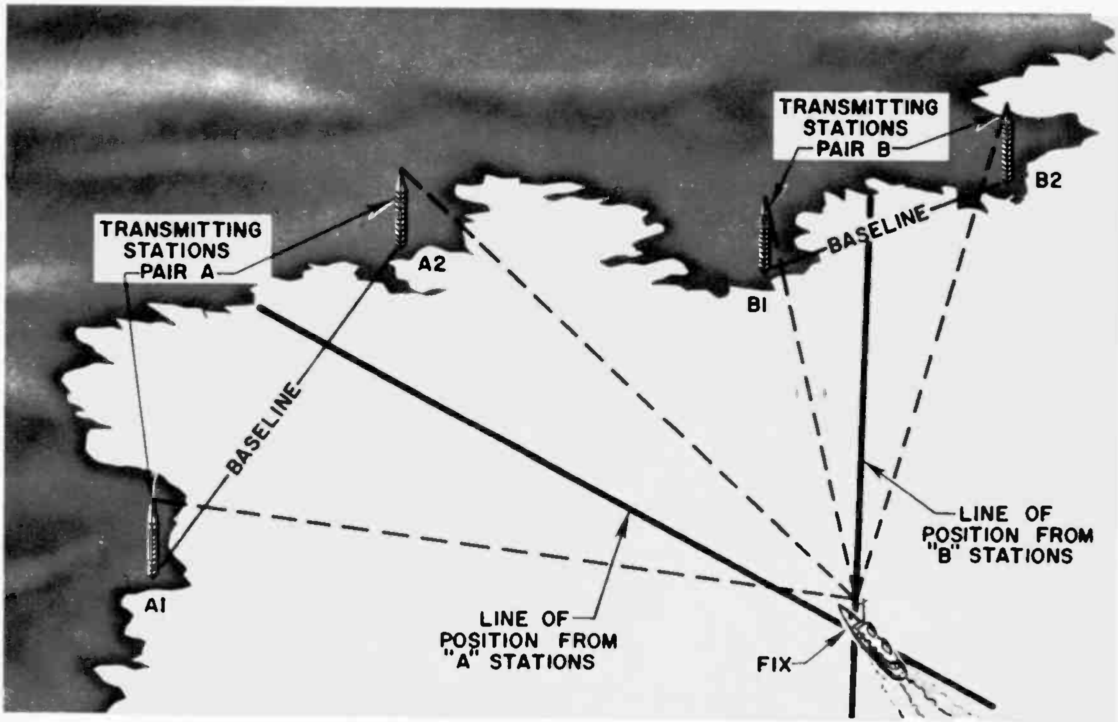
What happens when bad weather blots out the sun and stars? Navigator lost? Not if he has LORAN!



A 300-foot LORAN antenna (left) is flanked by communications antennas, Cape Blanco lighthouse. Below, technicians check transmitter pulse width.

LIGHTNING zipped down the guy wire of the 300-foot steel tower and danced along a wire fence. It was a rugged night at the isolated U. S. Coast Guard Station on Oregon's Cape Blanco. The historic lighthouse shone little farther than a sailor could throw his hat. But in an adjacent building, electronic signals continued to reach out across the rough North Pacific helping to guide ships and planes as far as 1400 nautical miles away. These signals, part of the world-wide LORAN system, are of vital importance to safe navigation.

The Cape Blanco station is one of 60 LORAN installations strategically placed on the globe. Fifty are operated by the United States; 6 by Canada; Denmark 2; Iceland 1; and the United Kingdom 1. The world's principal sea and air lanes are covered by LORAN 24 hours a day, providing navigators on or over the



Lines of position are found by measuring time difference between signals from paired LORAN stations. Navigator's fix is established at point where two lines of position meet. Latitude and longitude are then obtained from LORAN charts.

ocean with accurate positions day or night and under practically any condition of weather or sea.

The term "LORAN" is derived from the initial letters of the words "LOng RAnge Navigation." Ordinarily, over water, ranges may be expected from 500 to 900 nautical miles during the daytime and up to 1,400 nautical miles at night.

The principle of operation is based on the difference in travel time (in millionths of a second) between radio signals from two transmitting stations spaced several hundred miles apart. Pulses from one station are delayed ever so slightly so as to arrive last.

On the ship or aircraft, a LORAN receiver-indicator electronically determines the difference in times of arrival between pulses from the "master" and from the "slave" (or second) station. This measurement yields a line of position, as indicated on a specially prepared area chart. The intersection of two or more lines of position fixes the location of the ship or plane.

LORAN utilizes radio because radio waves have a constant speed and hence a direct relationship exists between time of travel and distance traveled. Thus, measurement of time is, in effect, a measurement of distance itself.

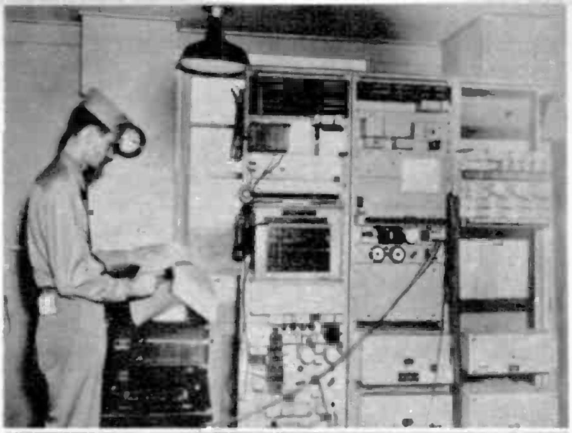
The radio signals which are transmitted by LORAN stations are not continuous transmissions, such as those of commercial broadcasting stations, but are "pulse" signals, short bursts of radio energy transmitted at regular intervals. The use of specially timed "pulse" signals permits the signals to be properly identified by the receiving ship or plane.

The Cape Blanco LORAN station, for example, is a double slave station paired with Cape Arena, Calif., on one chart line, and with Point Grenville, Wash., on another LORAN line. Pulses having a peak power of almost a million watts are transmitted on 1950 kc. The repetition rate is 33⅔ cycles per second.

The receiver-indicator equipment

[*Continued on page* 115]

Complex radio and teletype systems connect the Cape Blanco LORAN station with other Coast Guard units so that up-to-the minute weather data can be transmitted to ships and planes thus permitting the station to serve more than a single purpose.



Wreck of the small fishing boat Suzy *Ann*, blown off course by a bad storm, rests amid driftwood at the very doorstep of the Cape Blanco lighthouse. Almost all large ships and fishing trawlers carry LORAN gear to safeguard against a similar fate.

An off-the-air station serves no one. Here a technician repairs electronic timer used to obtain precisely synchronized LORAN signals.

Each LORAN station automatically keeps its own log, providing a continuous record of synchronizer. It must be checked regularly.

Three-element beam sits atop mast supported by guy wires. Directivity of this antenna would be to the left, a rotator will make it omnidirectional.

build a

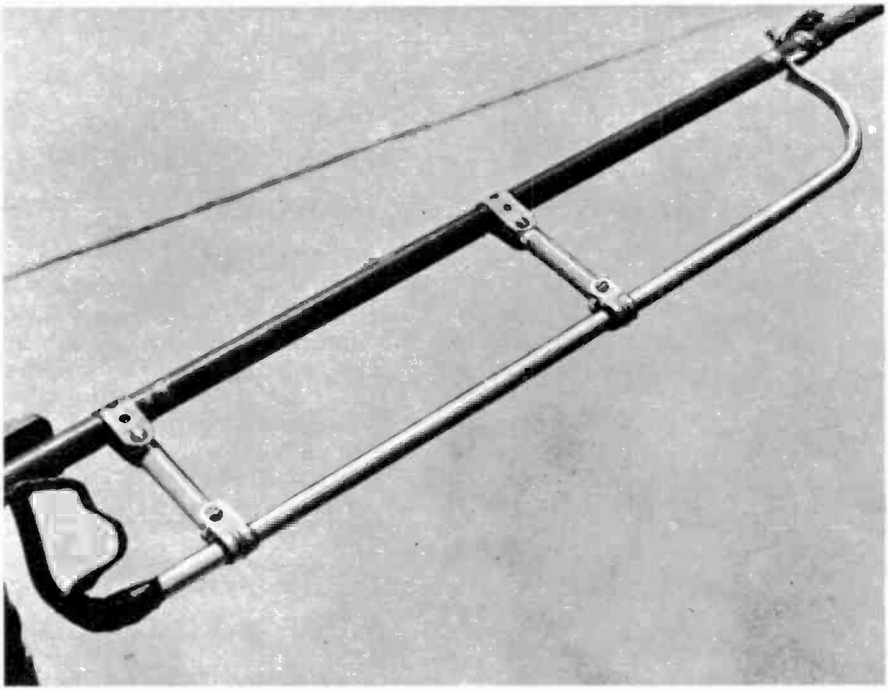
CB Beam Antenna

By Donald L. Stoner

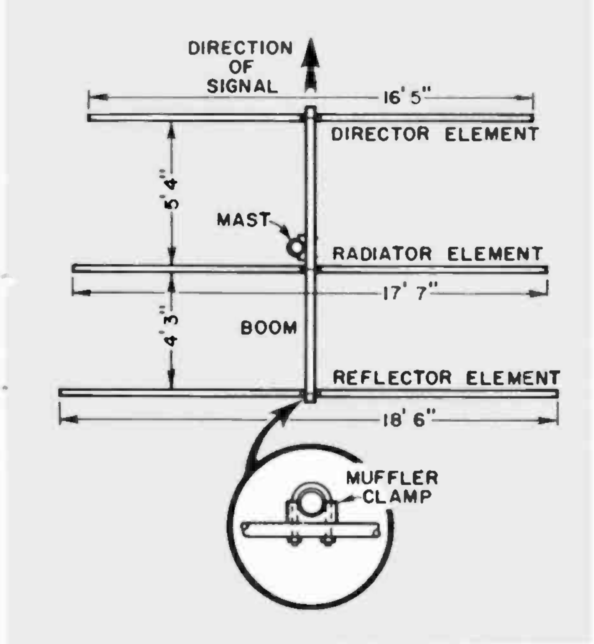
Triple your signal strength with a beam—and pick up less interference on the crowded Citizens band.

EVEN though the government limits your power to five watts input, you can increase your range if you construct a *beam antenna*, which should just about triple your signal strength. This device is a variation of the simple dipole antenna, however, *parasitic elements* are added to focus or concentrate the radio energy. Thus you can squirt your signals in any desired direction just like a water hose. This, of course, reduces interference to and from other stations.

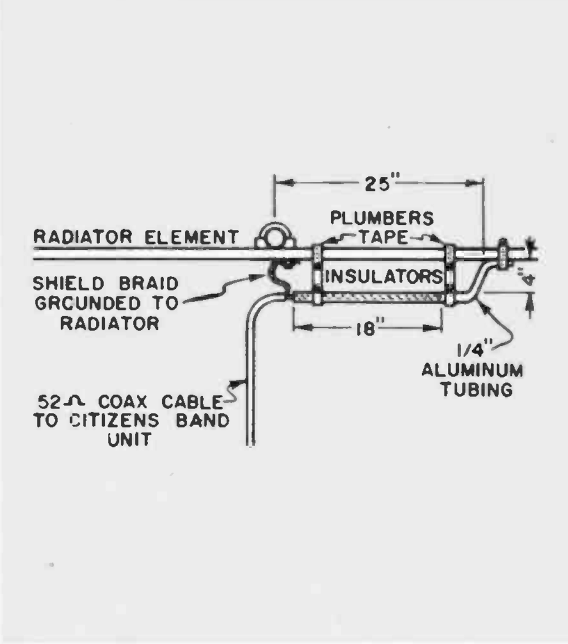
The three elements are supported by a 10 foot length of 1½ inch thin-wall conduit. This part of the antenna is called the boom. Automobile muffler clamps are used to secure each element to the boom. An additional [*Continued on page* 106]



Close-up of gamma tube, held to radiator by two insulators, and clamp at right end. Note that left end of tube is taped to prevent moisture from affecting performance.



Follow these dimensions and mechanical details for construction of boom and 3 elements.



Detail for gamma tube construction. This matching device hangs below the radiator.

Milt Kiver on

Probes

These valuable accessories extend the range of measurements you can make with a meter or 'scope.

PROBES are auxiliary devices used primarily with VOM's, VTVM's and oscilloscopes. They are designed to enable these instruments to perform measurements that could not be made without them. For example, a vacuum-tube voltmeter can ordinarily measure up to 1,000 volts DC without any special probes. However, by substituting a high voltage probe in place of the conventional probe, voltages up to 50,000 volts can be measured. This is one illustration; there are others as we shall see presently.

High-Voltage Probes

A high-voltage probe is a probe that contains an exceedingly high resistor within its housing. All of the applied high voltage,

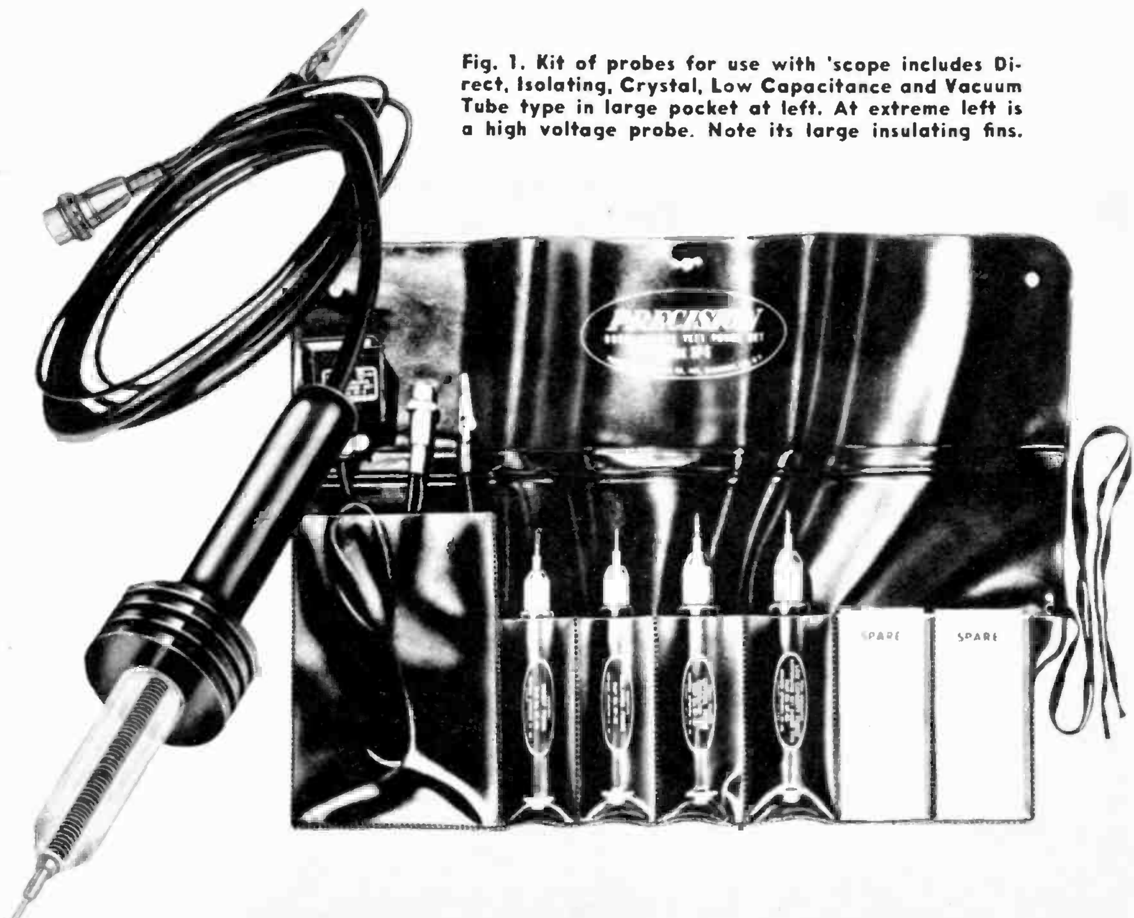
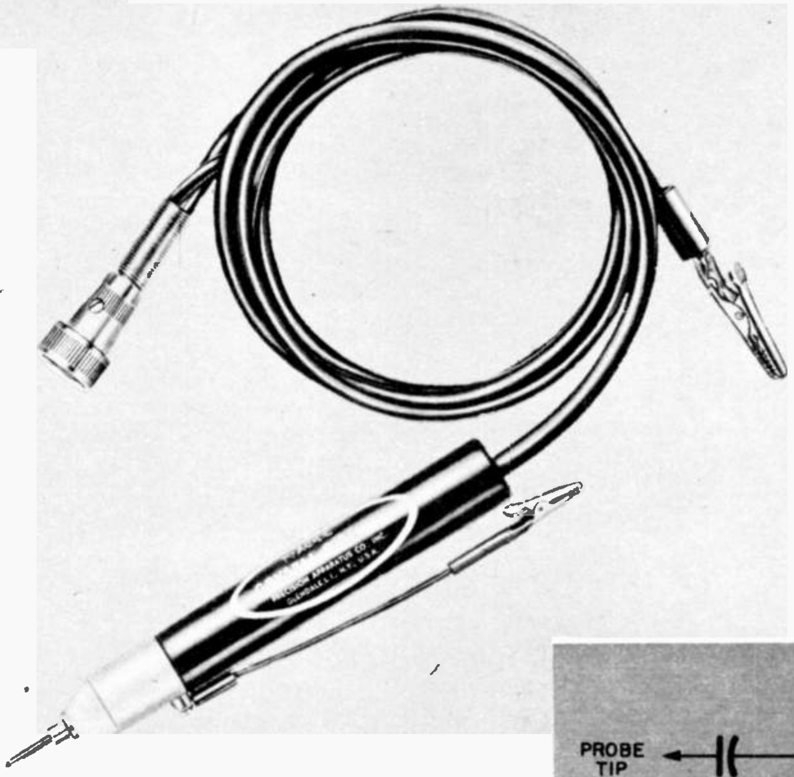


Fig. 1. Kit of probes for use with 'scope includes Direct, Isolating, Crystal, Low Capacitance and Vacuum Tube type in large pocket at left. At extreme left is a high voltage probe. Note its large insulating fins.



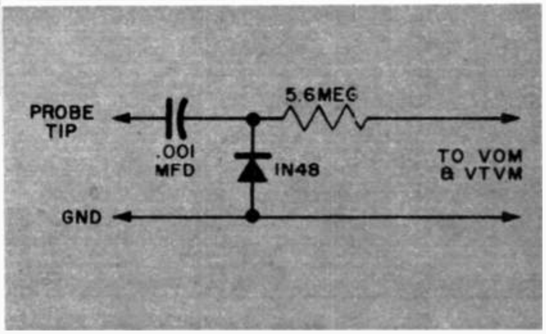


Fig. 2. RF probe enables a meter to measure high frequency voltage. It is useful in signal tracing RF and IF stages. The 1N48 rectifier in the schematic changes input to DC.

except a small part of it, is absorbed by this probe resistor. Thus, if 30,000 volts is being measured and the voltmeter is set to its 1,000 volts scale, then 29,000 volts might be dropped across the probe internal resistor and only 1,000 volts appears across the voltmeter input.

Physically, the high voltage probe appears as illustrated in Fig. 1. It is constructed of bakelite, lucite, polystyrene, or some other suitable plastic material. The overall length, from probe tip to handle end, is considerably greater than the conventional VOM or VTVM probe. This is done purposely to prevent any possibility of arc-over between the tip and the person grasping the handle.

High voltage probes must be specifically fashioned to the voltmeter (VOM or VTVM) with which they are being used. This stems from the fact that any applied voltage divides between the probe resistor and the input resistance of the voltmeter and the latter value is different for each instrument. In VTVM's the input resistance for DC voltage measurements remains fixed for every setting of the range control. In VOM's this resistance will change with each range setting and is arrived at by multiplying the ohms-per-volt value of the instrument and the highest value of the range in question. For example, if a 20,000 ohms/volt VOM is set to its 5,000-volt range, the input resistance of the VOM is 5,000 × 20,000 or 100 meg.

Some probe manufacturers have available a variety of different probe

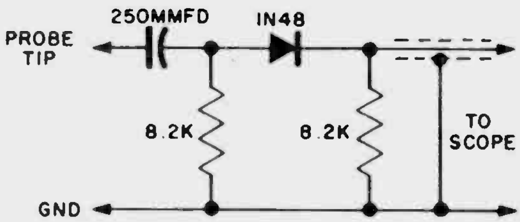


Fig. 3. RF detector probe enables 'scope to display signal modulation.

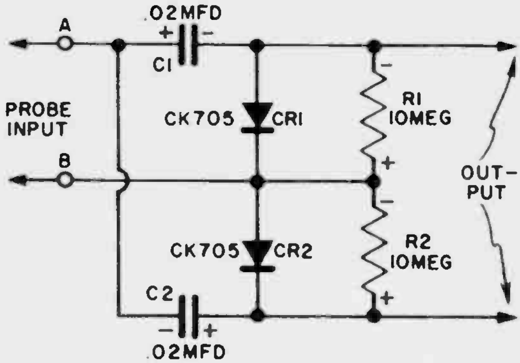


Fig. 4. Peak-to-peak RF probe uses 2 diodes to double its output voltage.

Probe with tiny vacuum tube rectifier permits high accuracy measurement.

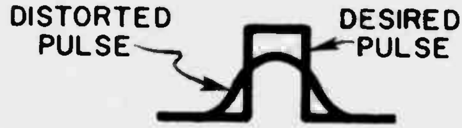


Fig. 5. Use of 'scope without low-capacity probe produces distortion of square waves.

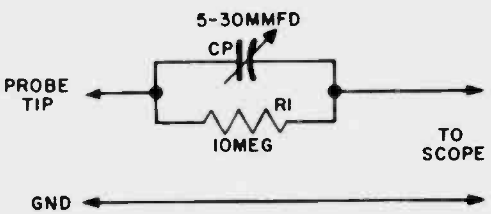


Fig. 6. Capacitor CP in low-capacity probe trims probe for best square wave response.

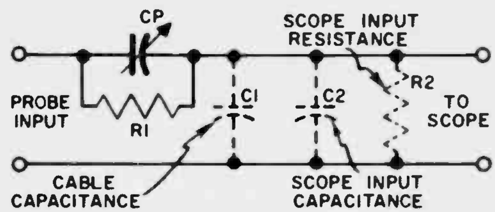


Fig. 7. Equivalent circuit (described in text) of low capacity probe, cable and 'scope input.

resistors, so that a number of VOM's and VTVM's can be matched. In the case of a VOM, only those with movements of 20,000 ohms/volt or higher are suitable for such probes. Movements with lower ohms/volt values require too much current which, if drawn from most high-voltage sources, would cause the voltage to drop.

It is quite simple to determine what value the probe resistor should be for any given VOM or VTVM. In the case of a VOM, it is necessary to know what scale will be used during the high-voltage measurements. Let us assume that the 5,000-volt scale is to be employed on a 20,000 ohms/volt VOM. We desire to be able to measure a maximum of 50,000 volts; this requires a scale factor of 10.

Formula to compute probe resistor is:

$$R_{probe} = M\ (R_{input}) - (R_{input})$$

where:

R_{probe} = resistance of probe
M = scale factor
R_{input} = input resistance of VOM on scale designated.

For example given,

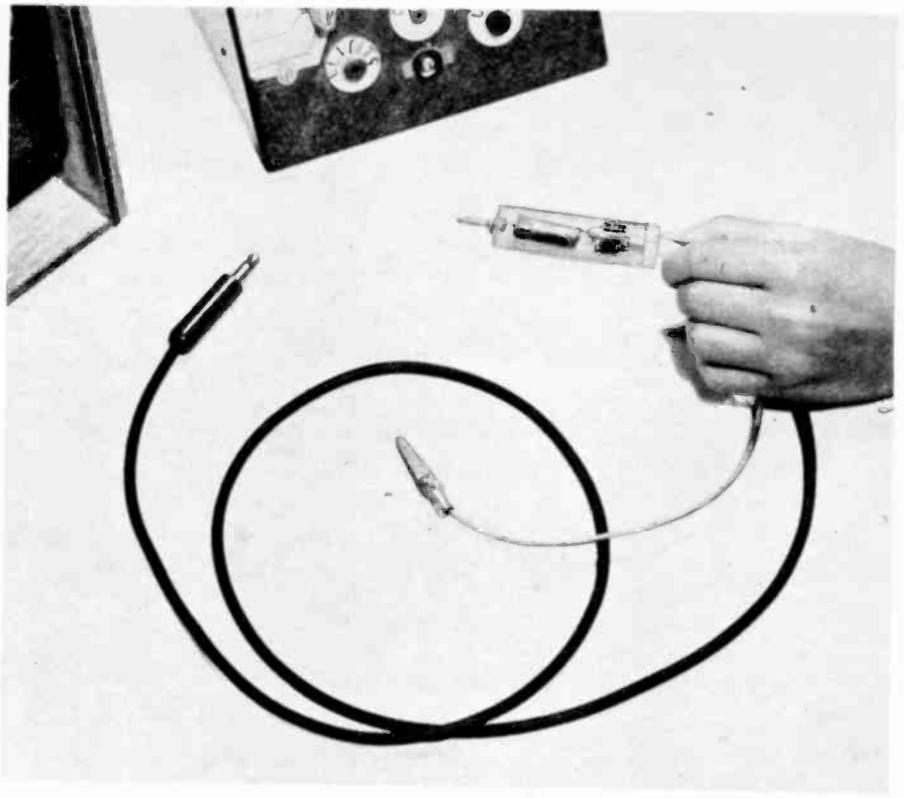
$$R_{probe} = 10\ (20{,}000 \times 5{,}000) - (20{,}000 \times 5{,}000) = 900 \text{ megohms.}$$

To find the probe resistor for a VTVM, the formula is modified slightly because VTVM's use a probe for normal DC voltages which contain a 1-meg resistor in it. This resistor is taken into account when the scales are calibrated and it *must* be considered when the resistance of the high-voltage probe is being computed.

To illustrate, assume a VTVM has an input impedance of 10 megohms and its regular DC probe has a resistor of 1 megohm. A scale factor of 100 is desired so that the probe may be used to measure up to 50,000 volts on the 500-volt scale. The equation now becomes:

$$\begin{aligned} R_{probe} &= M\ (_{input}) - (R_{input} - R_{cable}) \\ &= 100\ (10{,}000{,}000) - (10{,}000{,}000 - 1{,}000{,}000) \\ &= 991 \text{ megohms.} \end{aligned}$$

[*Continued on page* 110]



Probe built into a small plastic bottle. Phone plug goes to meter, alligator clip to equipment ground.

Make Your Own Probes

By Joe W. Rocke

For use with meter or 'scope, these three probes feature inexpensive parts and simple circuits.

CRYSTAL probes are to test instruments as solder is to a soldering iron; the two just naturally go together. The versatility of the probe makes it an indispensable tool for both circuit design and troubleshooting.

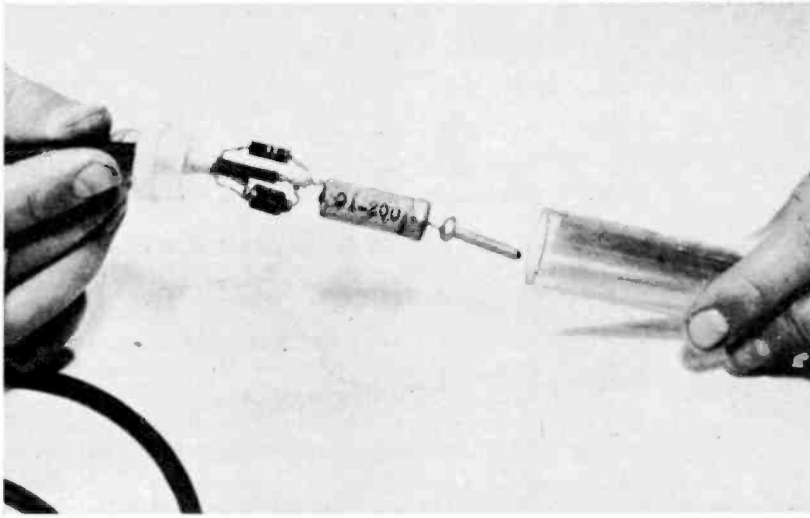
The spare parts box will usually yield the materials necessary to construct a probe. Aside from the germanium crystal the balance of the parts is not critical. Resistors and capacitors rated within 20% of the values shown are acceptable.

The crystal in the probe serves primarily as a rectifier. The 1N34 crystal, or its equivalent, will do for most probes. However, if the probe is to be used where high AC or RF voltages are likely to be encountered it is advisable to use a crystal having a higher voltage rating.

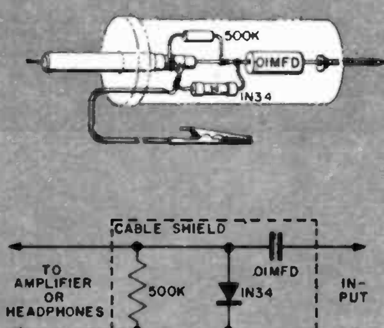
A container for the probe is where you find it. If you have a rich uncle who smokes El Ropo cigars packaged in capped aluminum tubes you have a made-to-order container. I used plastic.

Shielded cable must be used for the probe lead to shield against effects of body capacity and hum pickup. The crystal end of the probe does not ordinarily require close shielding unless the probe is to be used for VHF work.

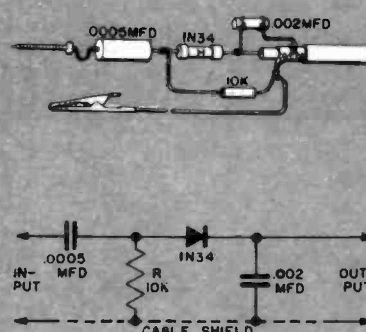
Construction of the probe is [*Continued on page* 106]



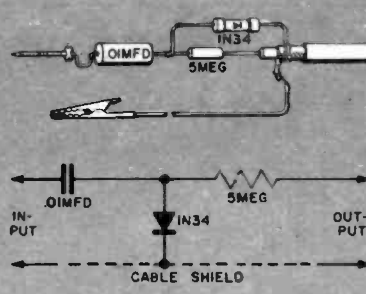
Wire probe as compactly as possible since parts are supported by their pigtails. Pointed screw is test prod which also serves to fasten assembly to case.



Signal tracing probe, used on an amplifier, will deliver audio to headphones. Demodulates RF, too.



Probe for use with VOM of at least 5000 ohms-per-volt. Will indicate RF on a 50 or 100 microammeter.



VTVM probe measures RF voltage in circuits that are easily disturbed by lower input resistance of VOM.

E I reports on the

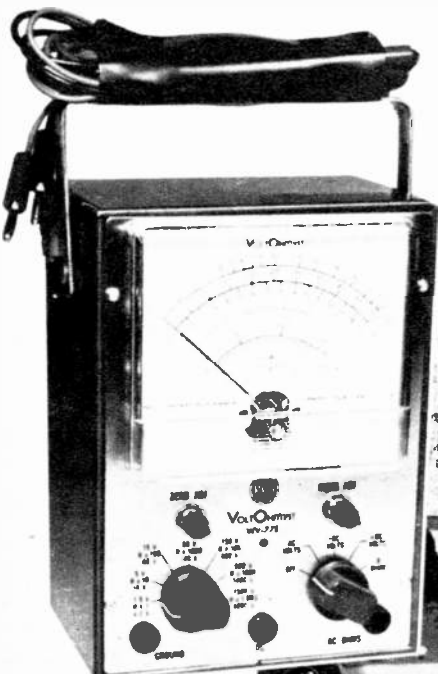
C

Long available in a factory-wired version, this sensitive VTVM is now being offered in kit form.

THE Voltohmyst, in kit form, marked the entry of RCA into the kit field. It closely resembles the "Junior" model of RCA's series of meters that include the Senior and Master Voltohmyst.

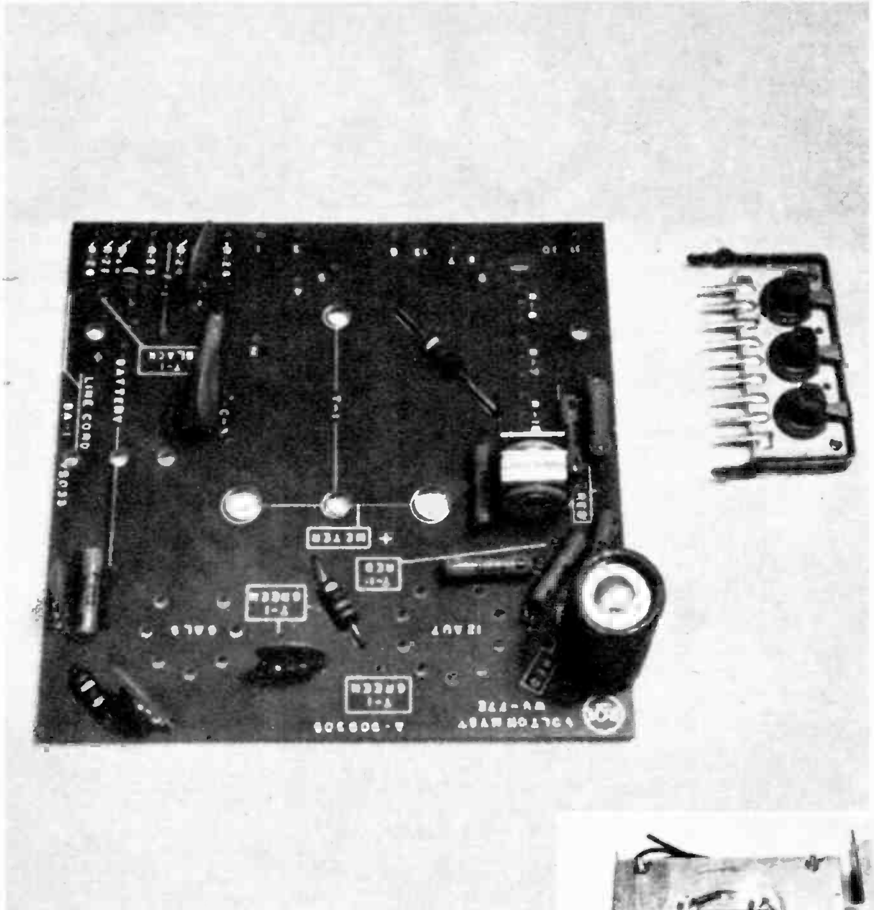
Thus, another VTVM, a most valuable piece of basic test equipment is available to the hobbyist or serviceman—at considerable saving. Wired at the factory the cost is $49.95, while kit price is $29.95.

The WV-77E(K) employs vacuum-tube voltmeter circuitry. On its DC ranges the input sensitivity is 11 megohms. This simply means that most circuits under test will be little affected by the voltmeter. Very high resistances, too, are measurable (up to 1000 megohms). [*Continued on page* 124]

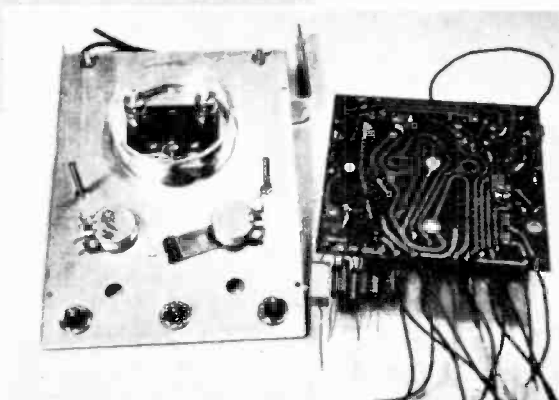


Front view of the completed WV-77E(K) is at left. A leatherette pouch, snapped onto the carrying handle, is a convenient place for probes.

Layout of parts included in the kit. Assembly instructions near the top are on a single sheet. Additional information is in booklets below.



Note the three calibrating pots to right of board. They are plugged into board and soldered to it as a single unit.



Underside of printed board ready to be joined to rear of front panel. Wires protruding from it will go to switches.

View of component side of printed board, after attachment to front panel. Two selector switches are along the bottom.

A self-contained net control station on wheels is operated by the Winston-Salem (N.C.) Amateur Radio Club in cooperation with the county's Civil Defense organization. Beam antennas are easily collapsed.

All About Ham Nets

By George Hart, W1NJM

Yes, there's a place for organized "rag chewing," but the byword of most ham nets is "service."

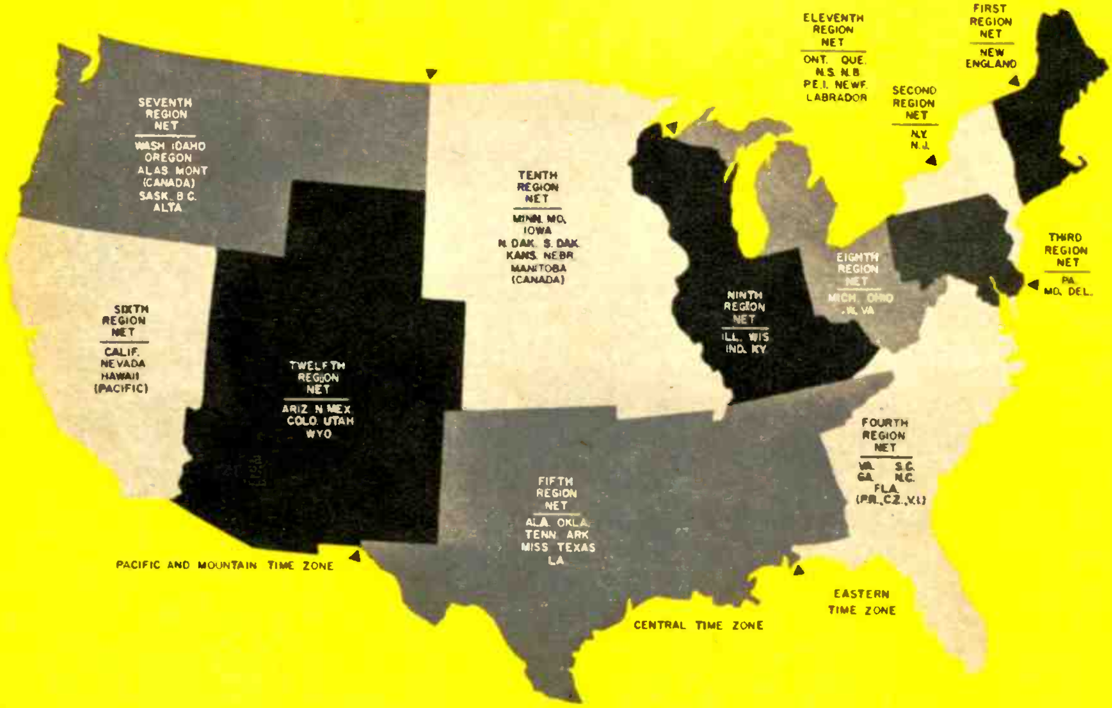
ALL over the amateur radio bands you can hear them—between 500 and 1,000 groups of operators calling themselves "nets." You might hear, for example, one station say: "Old man, you're interfering with the Podunk Net. Wonder if you'd mind standing by or moving to another frequency so we can clear our traffic."

The offending station may or may not move. He doesn't have to. A ham can operate anywhere in any amateur band (providing he has a Conditional Class license or better), and he has as much right to a particular frequency as the Podunk Net. Usually he will move since amateurs are courteous.

Young Julius Madey, K2KGJ, typifies unselfish ham radio operators all over the country. He has won an award for handling thousands of messages from servicemen in Antarctica.

L. A. Peek, W7BA, of Seattle, devotes much of his spare time and radio skill to the handling of traffic from military men stationed overseas. These messages are delivered gratis.

At the other end of the line, personnel on Operation Deep Freeze get the chance to talk with families back in the United States via ham phone patches. Beards keep out severe cold.



The National Traffic System is composed of over 100 amateur nets arranged so that messages can be handled in a minimum of time. State nets feed regional nets which feed area nets that are divided roughly into time zones.

Training of emergency network operators is a big job. Here volunteers check out for field stations with Civil Defense handie-talkies over their shoulders. This drill, being held in New York City, is one of several held each year.

Photo courtesy N. Y. City Civil Defense

What Are Nets?

When a group of amateurs all get on the same frequency and one station at a time transmits while the rest listen, we have a "round table." Usually they just take turns and each, in turn, talks about anything or about nothing. When one of the stations assumes charge and tells the others *when* to transmit and to whom, this station is called the "net control station" and the whole group operating in this fashion becomes a "net," or network. Sound regimented? It *is*, to a certain extent, although no one has to be in the net if he doesn't want to be.

Nets operate for a number of reasons such as preparing to provide emergency communications, or handling traffic (third party messages). There are training nets, such as those attempting to build up code speed. Some nets involve special interest groups within or outside the field of radio, such as doctors, dentists, teenagers, YLs (young ladies), or fraternal organizations. And some of them operate just for the good old fun of yakking together.

Some nets include only amateurs in a particular city or radio club, some extend through county or state, and some even spread from coast to coast and beyond!

Depending on what it does, what it is for and who is in it, a net might operate by voice ('phone), Morse code (CW) or radioteletype (RTTY). Amateur TV nets are also on the horizon. CW nets may be slow, medium or high speed, depending upon the proficiency level of the net members.

How can you identify a net when you hear one? Almost without exception they begin with a "call up." The net control station comes on at a prearranged time with a general call to all net members, something like this:

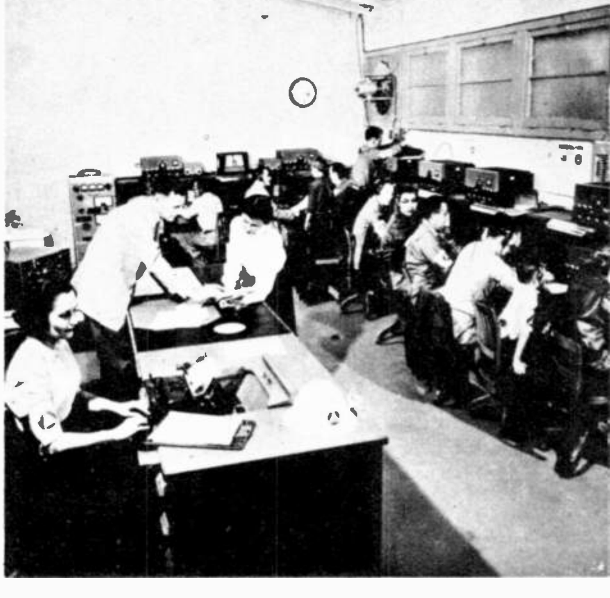
"Calling the Podunk Net, calling the Podunk Net, this is K2ABC, net control station. The Podunk Net operates daily on this frequency starting at 7:30 P.M., Central Standard Time, for the purpose of emergency communication in the Podunk area. Amateur stations operating on or near this frequency are re-

[*Continued on page* 122]

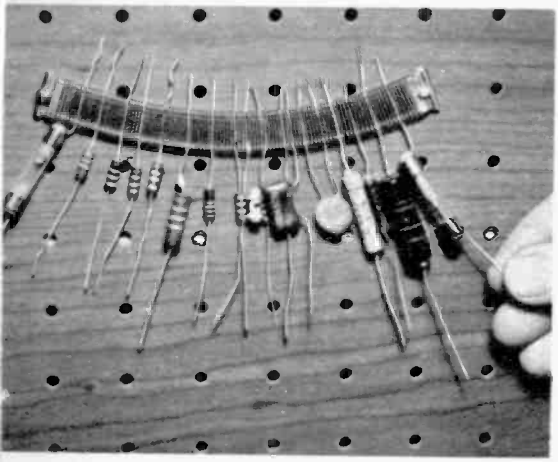
General Electric photos

Both men and women are coached in Morse code proficiency and network procedure on a voluntary basis. This group is from California.

Net control center on West Coast holds drill. Your life may depend one day depend on these hams. Boy, right, is licensed General class operator.

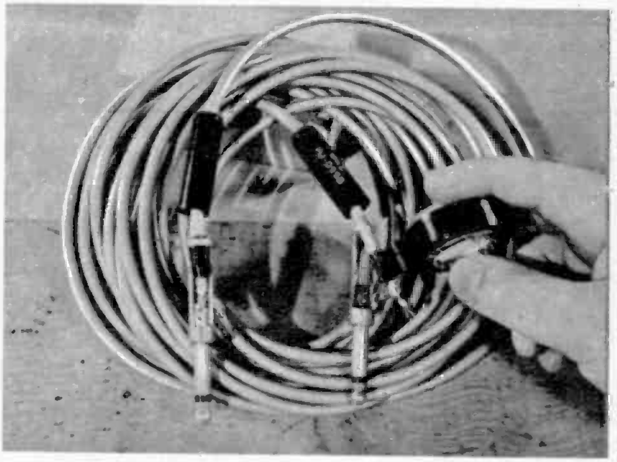


Try These



Watchband Parts Rack

An old spring-type expansion watchband can serve as a parts rack. Screw its two ends to your workbench or board.

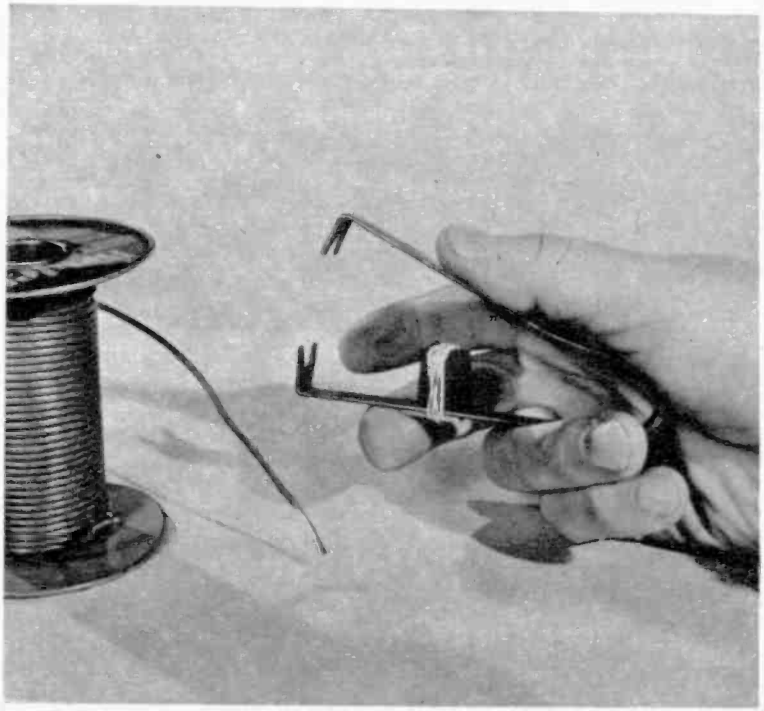


Tape Cushion

Repeated movement of center wire in phone jack causes break. Wrap with plastic electrical tape for tight fit.

Wire Stripper

To prevent stripper from cutting wire, mount block (from a rubber heel), between jaws. Square of cardboard under rubber band permits sliding adjustment for jaws.



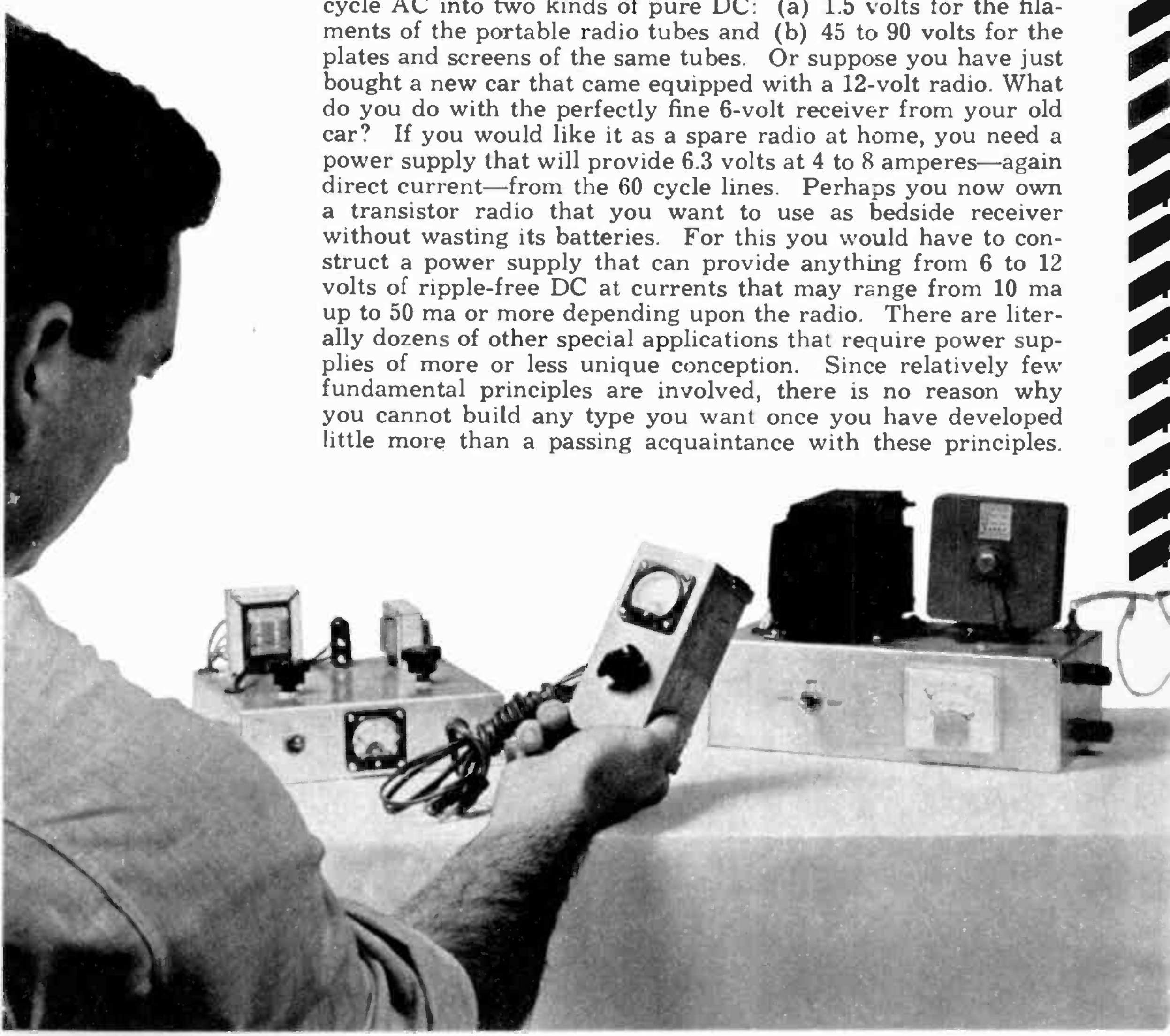
how to design and build

Power Supplies

By Harvey Pollack

Three of the most-often requested supplies are detailed here: for transistor sets, tube portables and auto radios—you can use them all on the AC line.

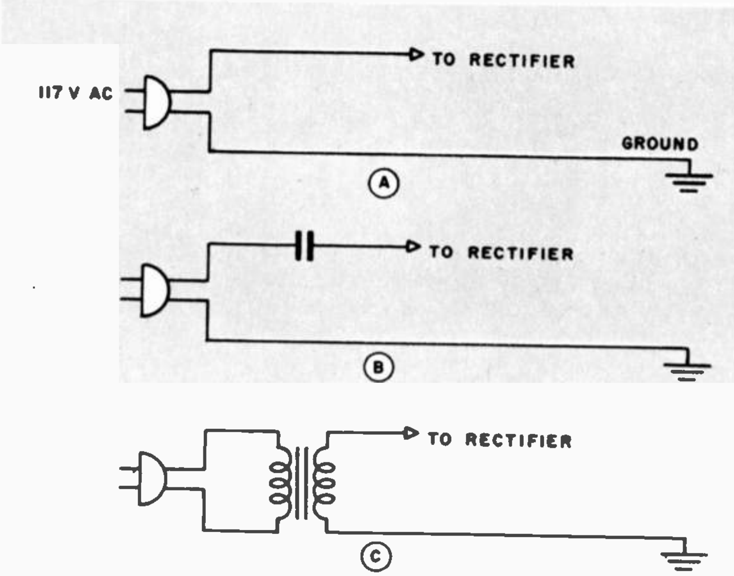
IN its broadest sense, a power supply is a device that converts one form of available electric power into another form needed to operate a given device. For example, when the batteries in your portable radio wear out and you want to use it directly from the AC lines in your home, you need a power supply of a very special kind. It must be able to convert the 117 volt, 60 cycle AC into two kinds of pure DC: (a) 1.5 volts for the filaments of the portable radio tubes and (b) 45 to 90 volts for the plates and screens of the same tubes. Or suppose you have just bought a new car that came equipped with a 12-volt radio. What do you do with the perfectly fine 6-volt receiver from your old car? If you would like it as a spare radio at home, you need a power supply that will provide 6.3 volts at 4 to 8 amperes—again direct current—from the 60 cycle lines. Perhaps you now own a transistor radio that you want to use as bedside receiver without wasting its batteries. For this you would have to construct a power supply that can provide anything from 6 to 12 volts of ripple-free DC at currents that may range from 10 ma up to 50 ma or more depending upon the radio. There are literally dozens of other special applications that require power supplies of more or less unique conception. Since relatively few fundamental principles are involved, there is no reason why you cannot build any type you want once you have developed little more than a passing acquaintance with these principles.



Classification of Power Supplies

Power supplies may be classified in terms of (a) type of coupling to the AC line, (b) the kind of circuit employed, (c) the nature of the filter or smoothing network, and (d) the kind of rectifier used.

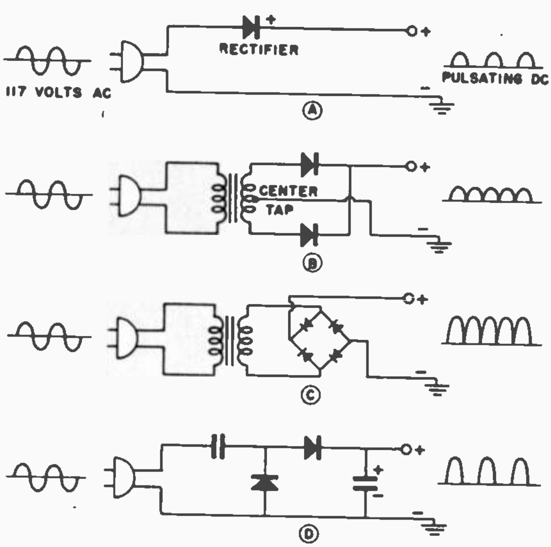
Fig. 1



Line coupling: Three types of line coupling methods are in common use: (1) direct connection to the AC lines without any form of isolation (Figure 1A); (2) capacitor isolation in the "hot" leg of the AC line connection (Figure 1B); and (3) transformer isolation (Figure 1C).

Of the three methods, transformer coupling offers several important advantages. Voltages may be stepped up or down by selecting a transformer with the proper turns ratio; in addition, a transformer completely isolates the power supply from the AC line thus reducing the hazard of electrical shock to the user. Although a transformer supply is the safest and most versatile of all, it does increase the cost, bulk and weight of the completed assembly.

Fig. 2



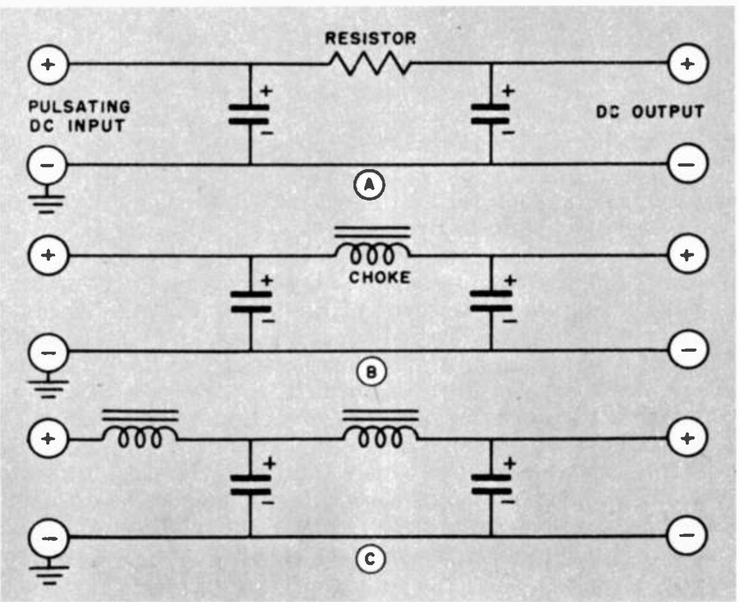
Circuit: Power supply circuits may be simple half-wave, full-wave, bridge or multiplier arrangements. In the half-wave circuit, only one-half of the available AC cycle is used (Figure 2A). This kind of power supply may be made inexpensive and compact, but does require larger filter components to reduce the residual ripple to an acceptable value.

By utilizing a center-tapped transformer and an additional rectifier section, the entire AC cycle is put to use. It is much easier to minimize hum voltages (ripple) in a full-wave system than in a half-wave type, but the cost and bulk are generally greater. (Figure 2B).

The bridge circuit (Figure 2C) eliminates the need for center-tapping of the transformer and makes the output voltage *twice* that of a full-wave circuit using the same transformer. A bridge requires 4 rectifier sections, however, in contrast to the 2 sections needed with full-wave center-tapped rectification.

Multiplier circuits are generally voltage-doublers but may be arranged to triple or quadruple the line voltage This is an inexpensive way to obtain high voltages without recourse to step-up transformers but is satisfactory only when the current demanded by the load is relatively small. (Figure 2D). This particular voltage doubler circuit is one of the most common in modern equipment; it is a half-wave type with one leg of the input line forming a "common ground."

Fig. 3



Filter Network: Smoothing components take the form of capacitors, resistors and chokes in various combinations. For our purposes, we may limit the filter networks to three types.

An R-C (resistor-capacitor) filter usually consists of two capacitors separated by a resistor as shown in Figure 3A. Since the first component that is encountered after the rectifier is a capacitor, this arrangement is called *capacitor-input*. Capacitor-input filters are utilized when the highest possible DC voltage is desired from a given AC input voltage.

A superior arrangement of capacitor-input is illustrated in Figure 3B. In this case, an inductor or *choke* replaces the filter resistor. Such a circuit is capable of better smoothing action, more constant output voltage under varying loads, and higher over-all voltage than that of Figure 3A. Its disadvantages include higher cost and greater bulk and weight.

When very constant voltage output and extremely low ripple is specified, a choke is generally used ahead of the first capacitor to make up what is called a *choke-input* filter network (Figure 3C). Obviously, a supply of this kind would be used only in costly equipment where weight and volume are not important.

Rectifier: Rectifiers are grouped as vacuum tubes, gas-filled tubes, or semi-conductors.

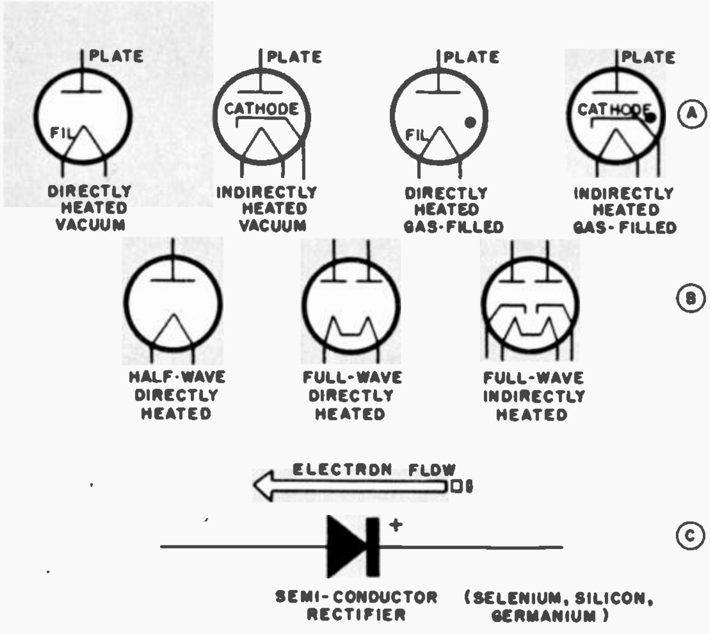


Fig. 4

Small power supplies equipped with rectifier tubes employ the vacuum type for the most part. Gas-filled tubes are found in supplies where the voltage and current requirements are higher than those normally anticipated in receiving and low-power transmitting equipment. In schematic form, the gas-filled rectifier is distinguished from the vacuum type by a black dot within the circle representing the tube's glass envelope (Figure 4A).

A rectifier tube containing a single plate (or anode) is used for half-wave rectification; one containing two plates is applied in full-wave circuits. (Figure 4B).

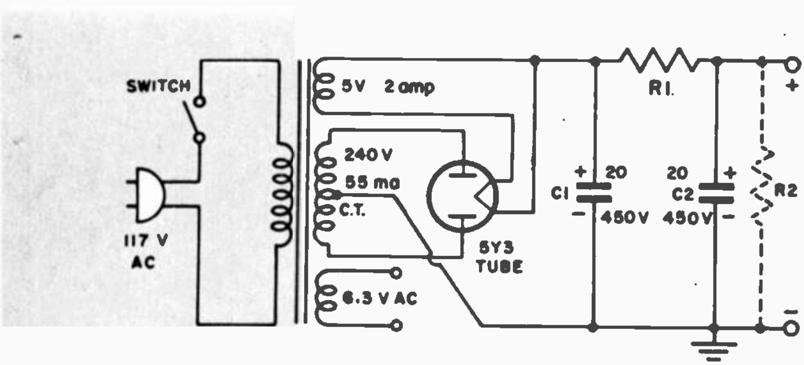
The semi-conductor rectifier—such as selenium and silicon units—has gained substantial popularity in the past few years. These have the great advantages of not requiring any filament power nor warm-up time. The only disadvantage they have is that they permit a small amount of reverse current to flow whereas tubes are virtually perfect insulators in the reverse direction. Improvements in recent rectifier construction techniques have made this disadvantage insignificant, however. The semi-conductor rectifier is shown schematically in Figure 4C. It is important to correlate the diagram with the direction of electron flow as illustrated. Note that electrons flow from the "flat" section of the schematic symbol toward the "point," leaving the flat portion positive.

Voltage and Current Considerations

In planning to design and build a power supply, you must take into account four fundamental electrical considerations, aside from the size, shape and cost of the finished product. You must first know the *final output voltage* required for the device you want to operate; whether or not you will get this depends not only upon the internal construction and selection of parts for the power supply, but also upon the *current your load will need at the specified voltage*. In addition, you should know beforehand what the *maximum allowable ripple voltage* can be without causing objectionable hum. Finally, you must consider a factor called *voltage regulation*, or ability of the power supply to maintain a constant output voltage despite fluctuations in the load current. We are particularly interested in the first two considerations and only incidentally concerned with the last two for reasons that will become clear as we explain the importance of these terms.

As an example, let us consider the following situation: you have a communications receiver that needs a power supply which will yield 240 volts at 55 ma with a ripple output of less than 1%. You make your choice of power supply type on the basis of available space and cost limitations and decide to use (a) transformer line coupling, (b) a full-wave center-tapped circuit, (c) a full-wave directly heated vacuum rectifier, and (d) an R-C filter network with capacitor input.

Fig. 5



First you draw up the schematic diagram as in Figure 5. The transformer should be selected next: reference to a parts catalog shows that the transformer you want has a high-voltage secondary output of 480 volts (i.e. 240 volts each side of the center tap) @ 55 ma, a 5 volt @ 2 ampere winding for the filament of the rectifier, and a 6.3 volt @ 2 ampere winding for the filaments of the receiver's tubes. (Typical transformer of this kind—Stancor type PC-8402.) You select a suitable full-wave rectifier having a 5 volt @ 2 ampere filament (the 5Y3), and you are ready to choose the filter capacitors.

To keep the hum level low (1% or less), you could work out the entire filter system from a set of complicated equations available in any good engineering text. For the average person, however, this is a needless chore because there is a very simple and convenient rule of thumb you can use. For a capacitor-input filter using two filter capacitors and either a resistor or a choke, each capacitor should have a capacitance obtained by:

$$C = \frac{5000}{E}$$

where C is the capacitance in microfarads and E is the approximate voltage obtained from a full-wave, 60 cycle input. (For a half-wave input, change the 5000 in the above equation to 10,000.) After determining C, if you find that there is no standard capacitor of this size available, go to the *next higher* value.

Thus, in our example, the filter capacitors should each be:

$$C = \frac{5000}{250} = 20 \text{ microfarads.}$$

Since the negative terminals are connected to the common ground, a dual section common-negative capacitor (such as the Sprague TVA-2730 or the Cornell-Dubilier CD-2245) having a rating of 20 mfd-20 mfd @ 450 volts can be used. It is always an excellent idea to use a capacitor having a larger voltage rating than the highest potential to be reached during operation.

The last step involves the calculation of the value of the filter resistor R1 in Figure 5. An input capacitor (C1) charges up to the *peak* line voltage from the transformer secondary. Since this transformer has an effective rating of 240 volts, the potential across C1 at no load is approximately 240 × 1.4 or about 340 volts. Since we want 240 volts output, there will be a voltage drop of 100 volts in R1. At the rated current of 55 ma, we find the value of R1 by substituting in Ohm's Law as follows:

$$R = \frac{E}{I} = \frac{100}{.055} = 1800 \text{ ohms (approximately)}$$

and to find the power rating required for this resistor, we use the equation:

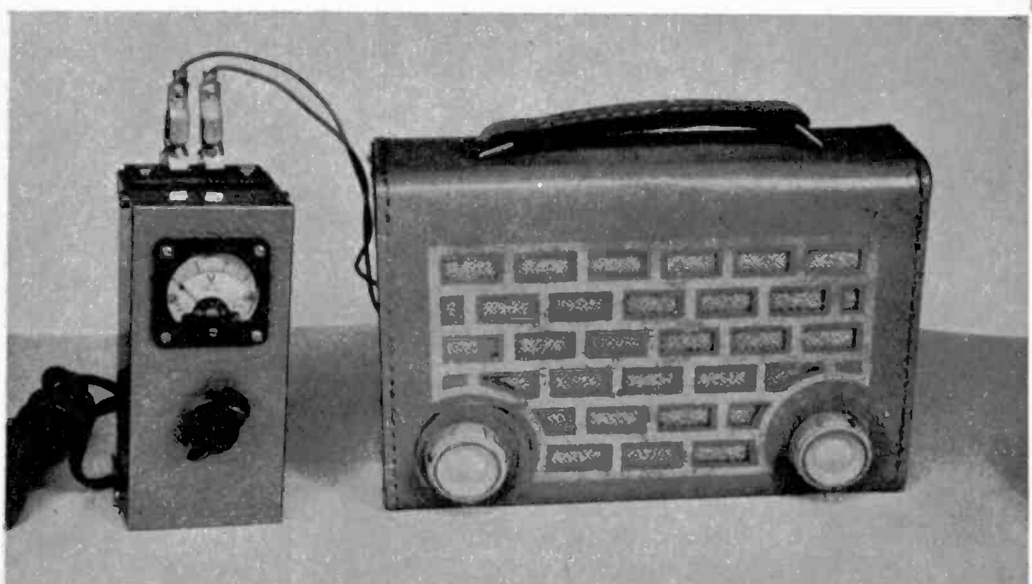
$$P = I^2R = (.055)^2 \times 1800 = 5.4 \text{ watts}$$

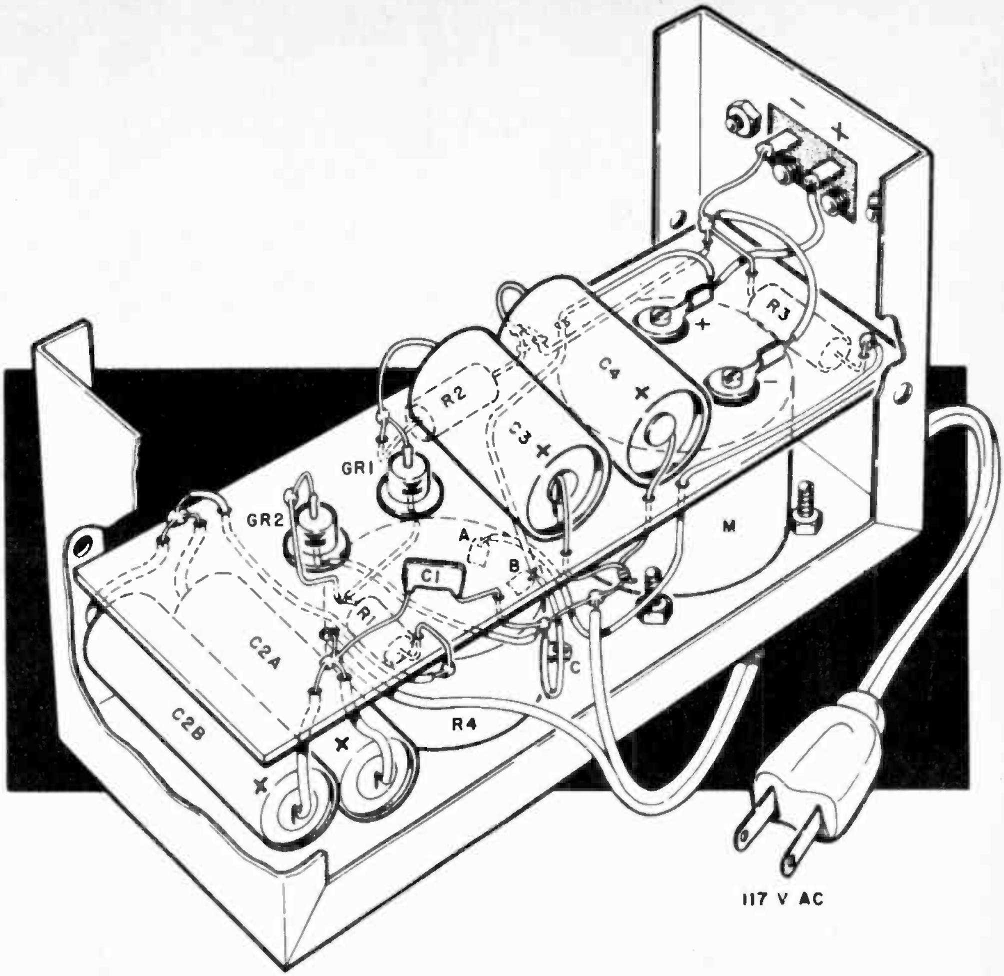
so that for a nice large safety factor, we could use a 10 watt resistor. The nearest commercial resistor available is a 2000 ohms @ 10 watt type such as the IRC PW-10-2000.

Note resistor R2 shown in broken lines in Figure 5. This resistor is unnecessary if the load is always connected to the power supply and if the current is always 55 ma, a hi-fi amplifier, for example. For situations in which the power supply may be operated without load, or if the drain is less than the rated current, R2 should be inserted. A 25,000 ohm 5 watt resistor in this position will take about 10 ma and serve to improve the voltage regulation as well as to discharge the capacitors should the load be absent.

Using design procedures similar to those just described, three special purpose power supplies are detailed in this article. The first is a tiny unit that will provide from 6 to 15 volts @ 5 to 60 ma for operating virtually any transistor radio; the second is a supply for any portable radio; the third will run a 6 or 12 volt auto radio or mobile citizen's band transceiver and serve as a battery charger.

Transistor power supply shown in use with a transistor receiver. Pair of leads from the supply connect to the battery clips at rear of the radio.





Wiring guide for transistor supply. Be sure that no bare wires touch the metal case. Output terminals at upper right are also insulated from case.

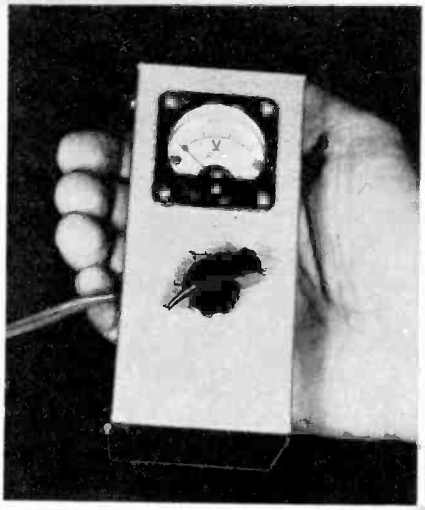
Transistor Radio Power Supply

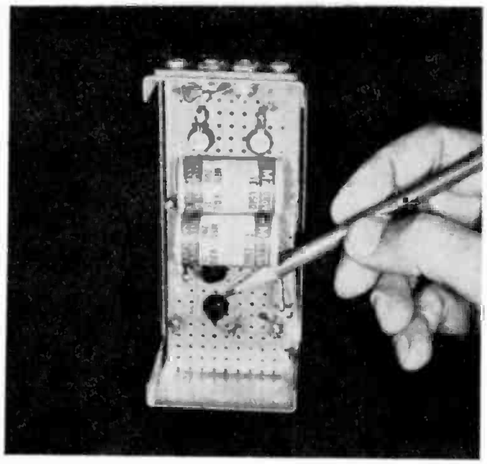
Classification: (a) Capacitor isolated, (b) half-wave voltage doubler, (c) R-C filter, capacitor-input, (d) two 1N91 rectifiers.

Specifications: Adjustable voltage output, from 6 to 15 volts @ any current from 5 ma to 60 ma. Ripple, approximately 1%.

Construction: This power supply is housed in a miniature cabinet, a 5"x2¼"x2¼" Minibox, equipped with a 0-15 volt voltmeter for precise adjustment of the voltage fed to the transistor radio it operates. If the power supply is to be used for one particular receiver, the meter is unnecessary.

The voltage doubler circuit operates as follows: on one half of the AC input cycle, GR2 passes current so that C2 becomes charged almost to the peak voltage of the AC line. On the next half-cycle, C2 discharges in series with the line voltage through GR1 into the input capacitor C3, charging this capacitor to the sum of the two voltages. Thus, if there were no load drawing current steadily through C2, capacitor C3 could charge up to 300

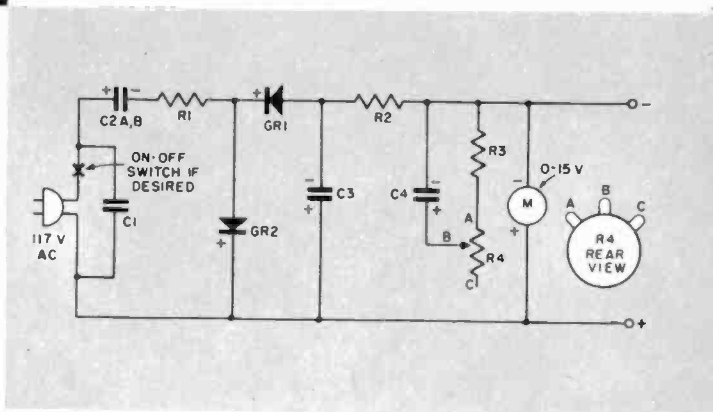




Above, voltmeter and voltage control knob are on front panel of supply. AC line cord emerges from left side.

Internal view of the supply is at top right. Pencil points to one of the 1N91 rectifiers mounted on board.

Note "X" in left of schematic. It indicates optional use of a SPST switch, not in the author's model.



volts or more! This, of course, would play havoc with a capacitor rated at 15 working volts.

R3 and R4 serve as a variable load, producing a voltage drop across C2 which limits the voltage applied to C3 to a maximum of 15 volts. It is very important that the wiper of R4 be kept at point A while the power supply is not connected to an external load. Should you then turn it on inadvertently without a load, C3 and C4 will be protected against overvoltage. R1 is a surge-protective resistor. Without it, either GR1 or GR2 may burn out if you happen to plug in the power supply at the instant that the AC cycle has reached its peak. C1 is a line filter capacitor whose function it is to by-pass line noises out of the power supply.

A small piece of perforated board supports the small components, the board itself being held in place by the meter terminal screws. Since there is no transformer isolation, *the metal case must not be made the common ground* since this would be inviting a dangerous, if not lethal, shock from the lines.

PARTS LIST

C1—.01 mfd capacitor 300 volt
C2A,B—4 mfd electrolytic capacitor 200 volt (use two 2 mfd in parallel)
C3,C4—200 mfd electrolytic capacitor 15 volt
R1—2.7 ohm resistor 1 watt
R2,R3—100 ohm resistor 2 watt
R4—1000 ohm potentiometer 3 watt wire-wound (IRC WPK-1000 or equiv.)
GR1,GR2—Germanium rectifier (GE type 1N91)
M—0-15 volt DC meter (Lafayette TM-100)
Misc.—case 5"x2¼"x2¼" (Bud CU-2104), perforated board 4½"x2"x2", one 2-screw terminal strip, line cord.

Portable Radio Power Supply

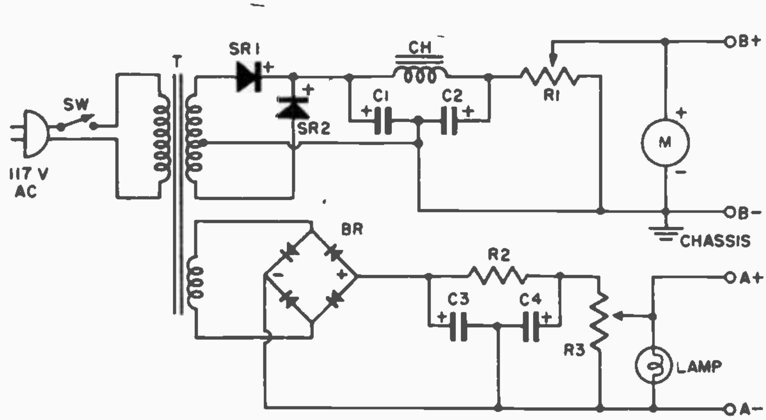
Classification: (a) Transformer isolated, (b) full-wave circuit, (c) L-C filter, capacitor-input, (d) rectifiers—two selenium rectifiers.

Specifications: "B" voltage supply adjustable from zero to 135 volts at any current from zero to 25 ma; ripple approximately 1%. "A" voltage supply adjustable from zero to 3 volts @ any current from zero to 250 ma; ripple less than 0.5%.

Construction: This should prove to be an extremely popular power supply for our experimentally-minded readers. It is ideally suited for powering any one of the tens of thousands of portable tube-type radios for which the owners no longer care to buy expensive "A" and "B" batteries. As the photos show, a meter is included to make the power supply more versatile but may be omitted once the proper voltage has been established for a given application. Furthermore, with the help of the accompanying graph, the "B" voltage need not be made variable since a small fixed resistor may be substituted for the potentiometer in the high voltage circuit.

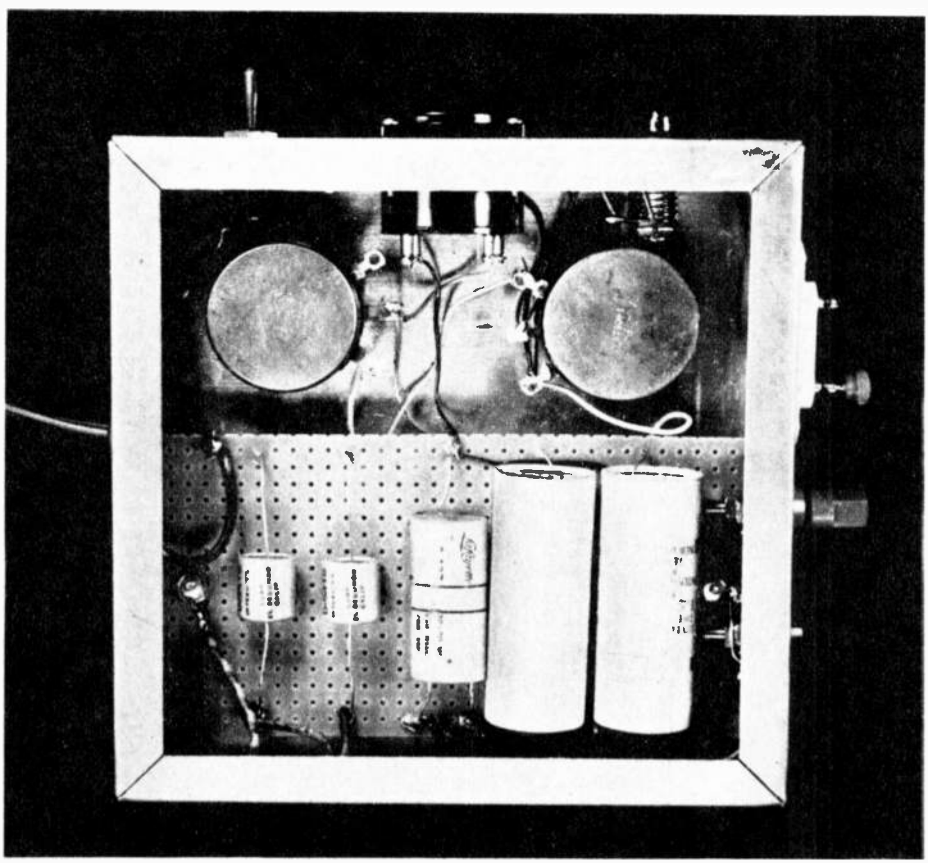
The "A" supply section utilizes a magnesium-copper oxide bridge rectifier of inexpensive type to provide full-wave output filtered by a capacitor-input R-C network. A 20 ohm wirewound potentiometer controls the DC output voltage, permitting adjust-

Portable radio power supply shown in use with an old battery radio. The supply replaces both "A" and "B" batteries displayed on top of the radio.



Schematic of portable radio power supply. Lamp at lower right is used in place of a meter in the "A," or filament voltage section.

Chassis underside. Perforated board, convenient for mounting parts, is supported at both ends by two long nuts and bolts with ½" spacers.

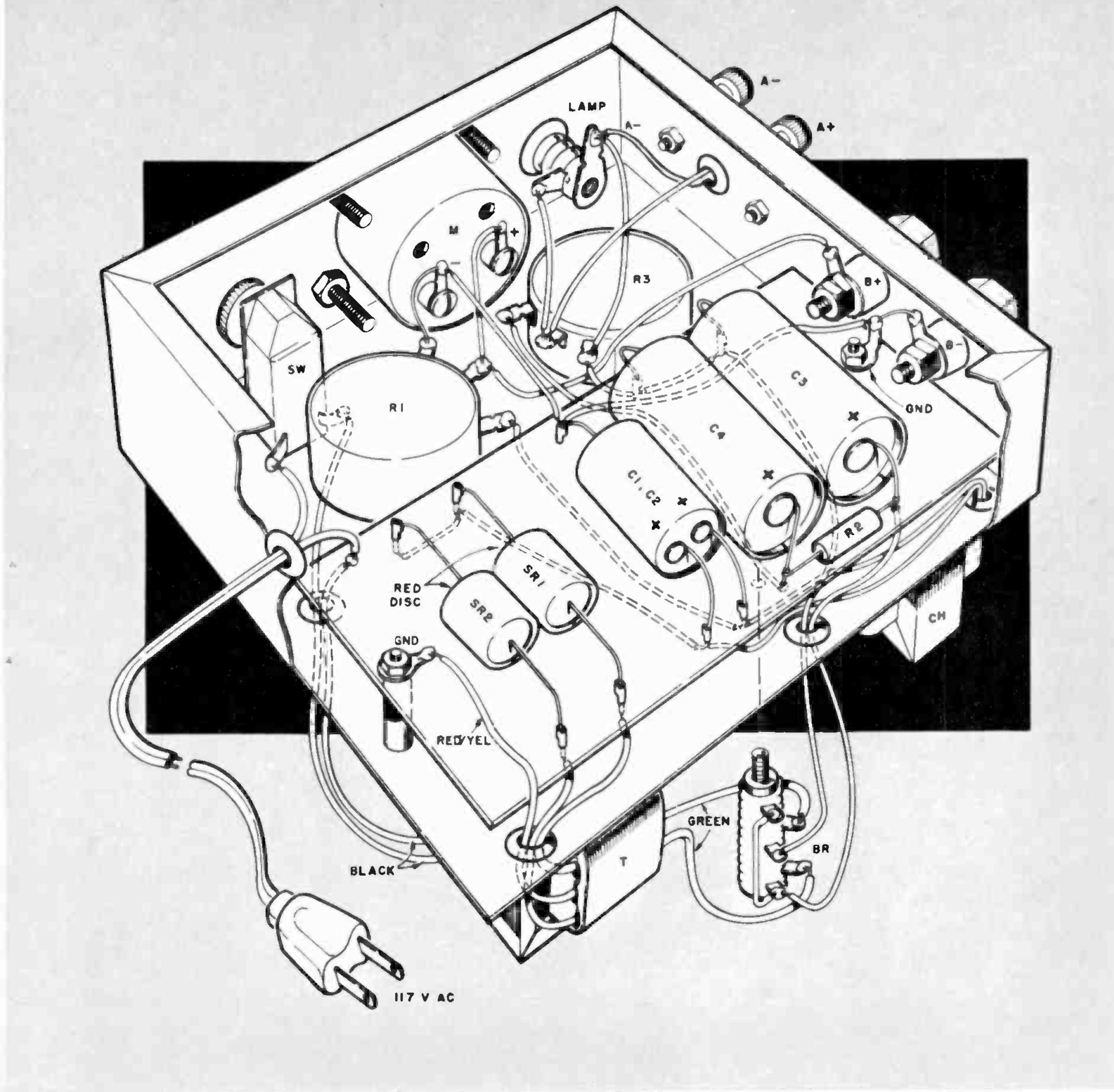


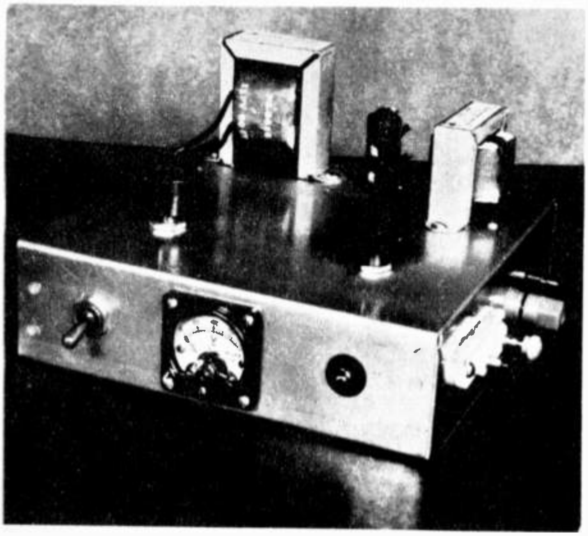
ment from zero to 3 volts at currents up to 250 ma. The "A" voltage is metered by a 2 volt pilot lamp (really a low-cost metering device!).

The use of a 6"x3½" piece of G pattern epoxy paper Vectorbord with .093 Vectorbord holes makes this a well-insulated and practical design. (Vectorbord in all sizes, push-in terminals for the .093 holes, and various other fittings are available from Vector Electronic Company, 1100 Flower Street, Glendale 1, California or from their distributors.) The Vectorbord assembly is mounted and pre-wired before securing it to the chassis. It is supported by machine screws passed through a ⅜" brass spacer at each end.

The wiring guide shows the construction of the power supply. Should you want to build the unit for operating one particular

Wiring guide for portable radio supply. Follow the pin layout on bridge rectifier BR, removed from main chassis at bottom, for reasons of clarity.





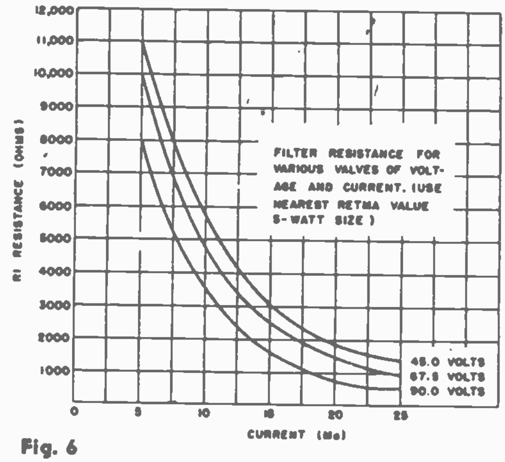


Fig. 6

Relative brightness of lamp, to right of meter, indicates filament voltage. See text for explanation of Fig. 6, used for selecting filter resistor.

radio, first determine the voltage required for the "B" circuit and the current that the "B" battery had to deliver in the original application. Then, by using the proper voltage curve in Figure 6, you can determine the correct value of resistor to use for replacing R1, the control potentiometer. This will eliminate two costly items: the meter and the wirewound potentiometer.

Since this power supply is transformer-isolated, the chassis may be used as common ground for the "B" supply. Neither "A" terminal should be grounded to the chassis, however.

If you build the power supply just as shown, the portable radio should be connected as a load to both "A" and "B" sections before applying power. Both potentiometers should be rotated to their zero-voltage positions when the switch is turned on. Now, gradually turn up the "A" control (R3) while you watch the indicator lamp. Since this is 2.0 volt type, it will indicate 1.4 volts when lit almost to full brilliance. With filament voltage adjusted properly, bring up the "B" voltage in accordance with the requirements of the receiver. Some portables were made for 45 volts, others for 67.5 volts, still others for higher voltages. Use the recommended voltage at all times to avoid blowing capacitors and overheating resistors. When used correctly, this power supply will make a portable radio perform as well or better than it did when battery-operated.

PARTS LIST

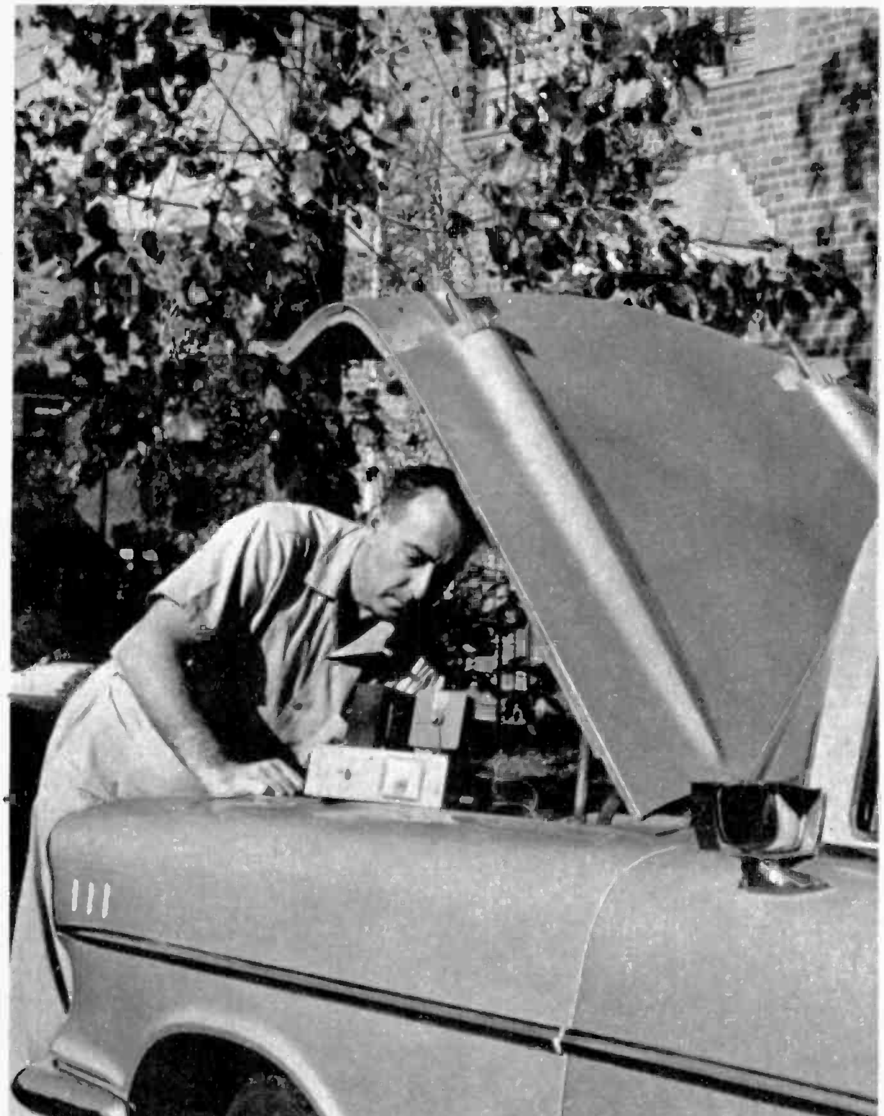
C1,C2—20-20 mfd electrolytic capacitor (dual-section) 150 volt
C3,C4—2000 mfd electrolytic capacitor 6 volt
CH—Filter choke 9 henry @ 50 ma (Stancor C-1215)
BR—Bridge rectifier Mg-CuS type for low voltage (Mallory 1B12R)
R1—10,000 ohm 3 watt wirewound potentiometer. See Fig. 6 (Clarostat Type 58)
R2—2.7 ohm resistor 1 watt
R3—20 ohm potentiometer 3 watt wirewound (Clarostat Series 10)
SR1,SR2—Selenium rectifier (Int'l Rectifier type D-5416)
SW—SPST toggle switch
T—Power transformer, primary 117 volt, secondaries 6.3 volts @ 1 amp, 250 volt CT @ 25 ma (Stancor PS8416)
Meter—0-200 volt DC (Lafayette TM-101)
Misc.—2-volt pilot lamp (Mazda #49), chassis 7"x7"x2" (Bud AC-405), "B" terminals 5-way Bakelite type (Lafayette "Jumbos"), "A" terminals twin binding posts red and black (Philmore #121), ½-inch spacers, perforated board.

Auto-Radio Power Supply and Battery Charger

Classification: (a) Transformer isolated, (b) full-wave bridge circuit, (c) capacitive filter, (d) rectifier—selenium bridge.

Specifications: 6 or 12 volts DC selected by switch; output voltages adjustable for currents ranging from 2 to 4 amperes for continuous use; up to 8 amperes at 6 or 12 volts available for intermittent use.

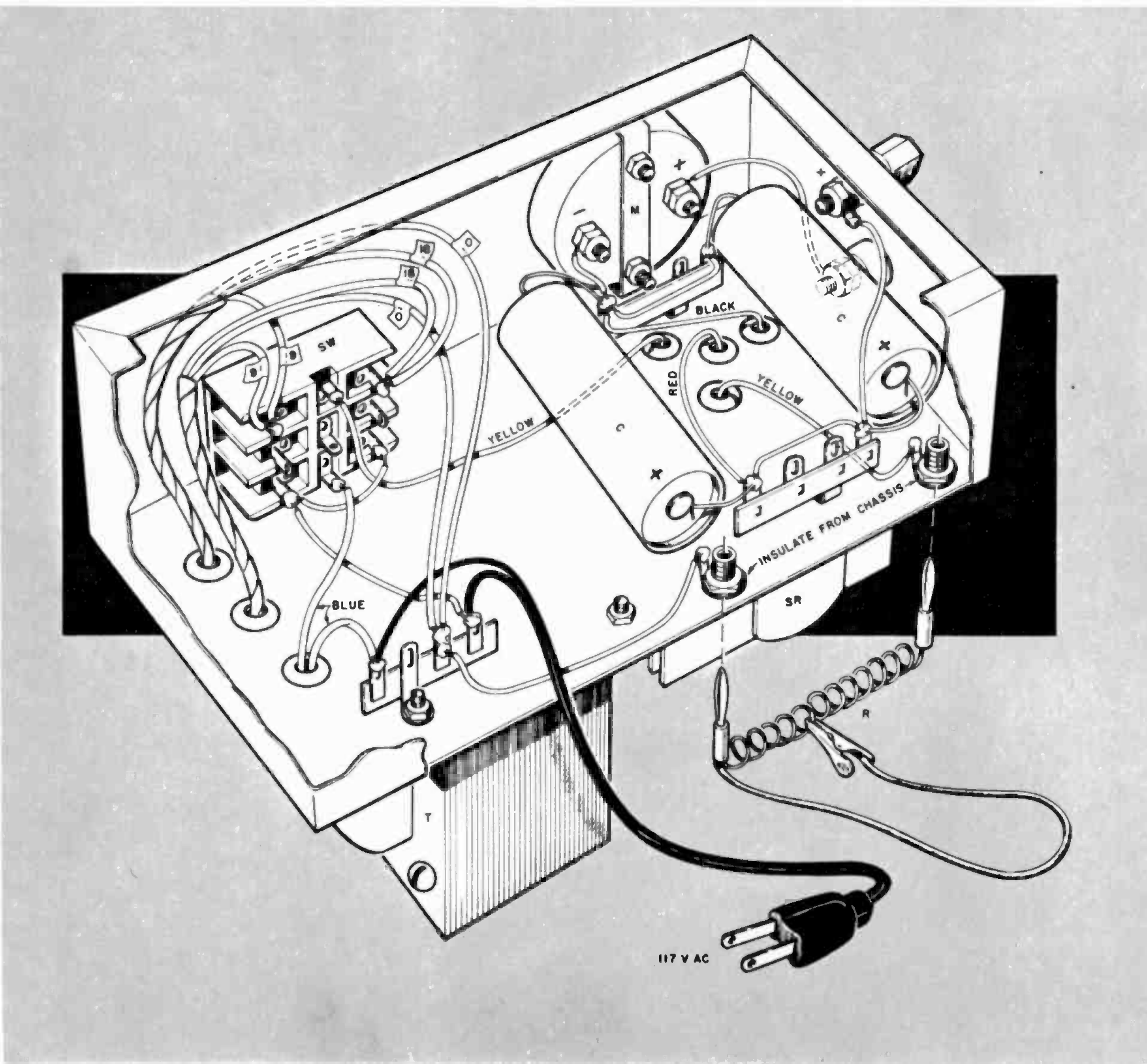
Construction: This power supply has several unique features. A switch with a neutral center position is used to turn the equipment off by breaking the transformer primary circuit, or to switch to 6 or 12 volt output on either side. A heavy capacitive filter reduces the ripple to approximately 2% to provide hum-free

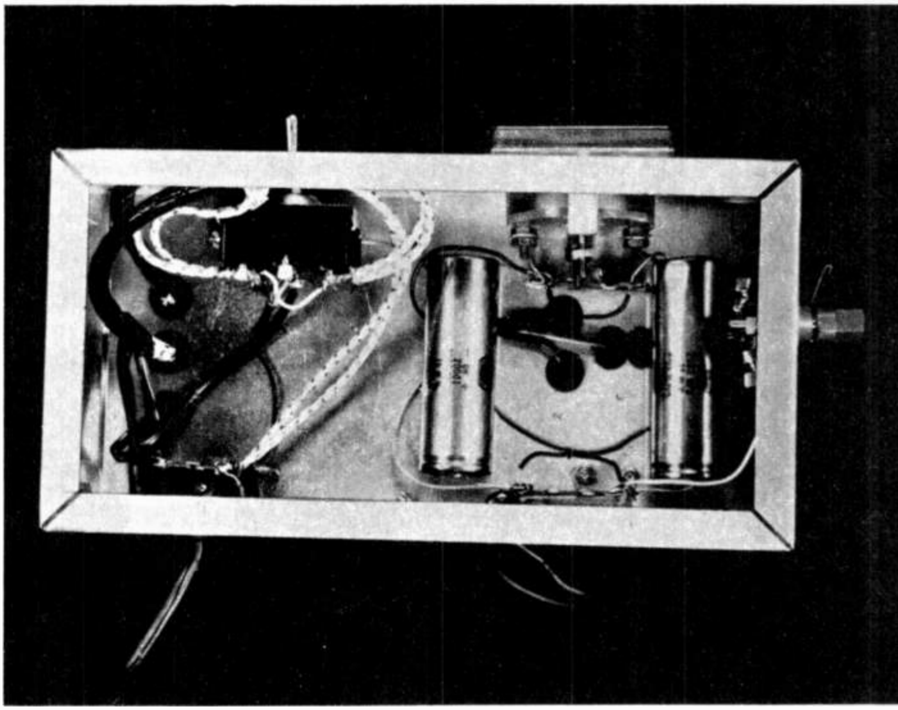


Auto radio supply in use as a car battery charger. It will supply either 6 or 12 volts.

operation of any auto radio or transceiver designed for mobile use. The use of a costly power potentiometer for fine control of output voltage under various current demands is avoided by means of a very simple expedient: a heating element from an old parabolic electric heater (such elements are available in hardware stores, but you may have an old heater around) is taken apart and sections of the nichrome coil used as a current-limiting resistor in series with the common transformer leg (see R in diagrams). Sections of different lengths ranging from 5 or 6 turns to 15 turns or more may be mounted on banana plugs as in the model, and a shorting clip employed to include as many turns as desired in the circuit. Exact specifications for heater element lengths cannot be given since various elements have different nichrome wire thicknesses. This is very easily determined by

Auto supply wiring guide. Resistor R, at lower right, is a length of nichrome wire, used in place of a more expensive rheostat. It adjusts output voltage.





Underside view of auto supply. The two large filter capacitors at right are actually connected in parallel to total the required 4000 mfd (part C).

experiment, however. Of course, if you don't mind spending about $5.00, you can use a 50 watt power rheostat in place of a plug-in resistance. (For example, an Ohmite Industrial Rheostat, Model 0311, 4 ohms, selling for $4.53 would serve admirably here.)

A word about the transformer would not be out of place. This transformer has two identical center-tapped secondaries rated at 0-9-18 volts AC each @ 4 amperes per winding. By connecting them in parallel, properly phased, the current output then rises to 8 amperes. The wire leads of this transformer (see parts list) are coded with tape markers showing which is the "0," "9," and "18" volt terminals of the windings, so that phasing is no problem. The selenium rectifier is rated at 4 amperes continuous (or 8 amperes intermittent). Should you want a rectifier of higher current rating for continuous operation of 8 ampere equipment, these are also available at the same distributor given in the parts list.

In this case again, it is suggested that the chassis *not* be made the common ground. Should you want to charge a battery right in your car, it is best if the chassis is neither positive nor negative just in case your car has a positive ground. In charging a battery, the positive terminal of the power supply goes to the + terminal of the battery and, of course, negative to negative. A 4-ampere charging rate is more than enough for an overnight charge.

A few precautions relative to construction and use of this power supply: (1) mount the selenium rectifier above the chassis in a vertical position as shown in the photos. This permits convection of air needed for maintaining proper operating tempera-

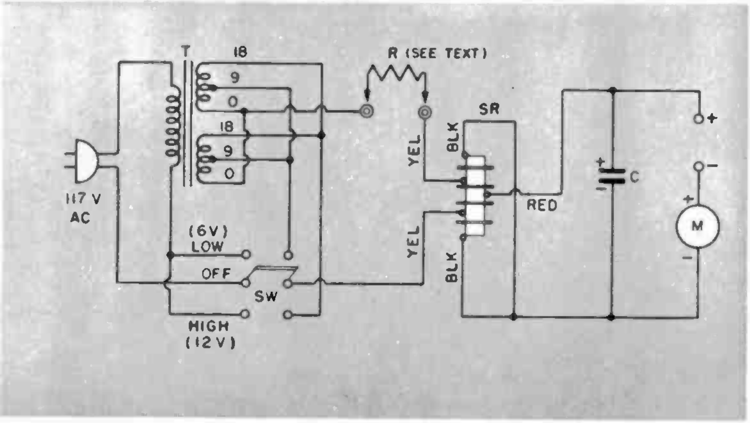
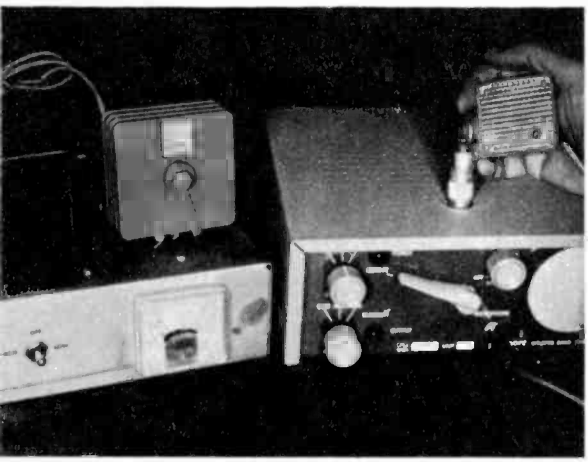


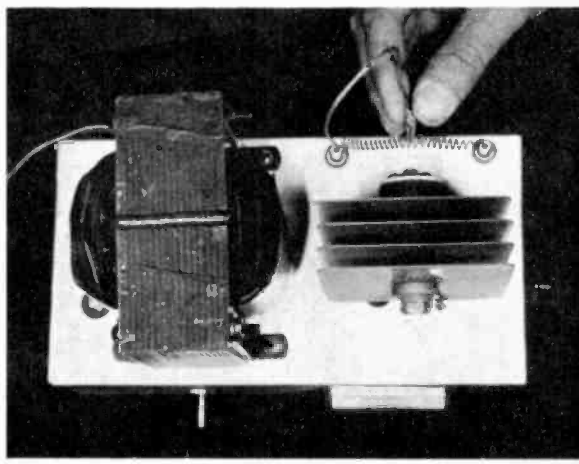
Fig. 7

R in the schematic at left is the nichrome wire. Note windings on secondary of T are in parallel.

Below left, supply is used to power a Citizens Radio set that's originally designed for mobile use.

Top view of supply. Output is adjusted by alligator clip which shorts out turns of nichrome wire.



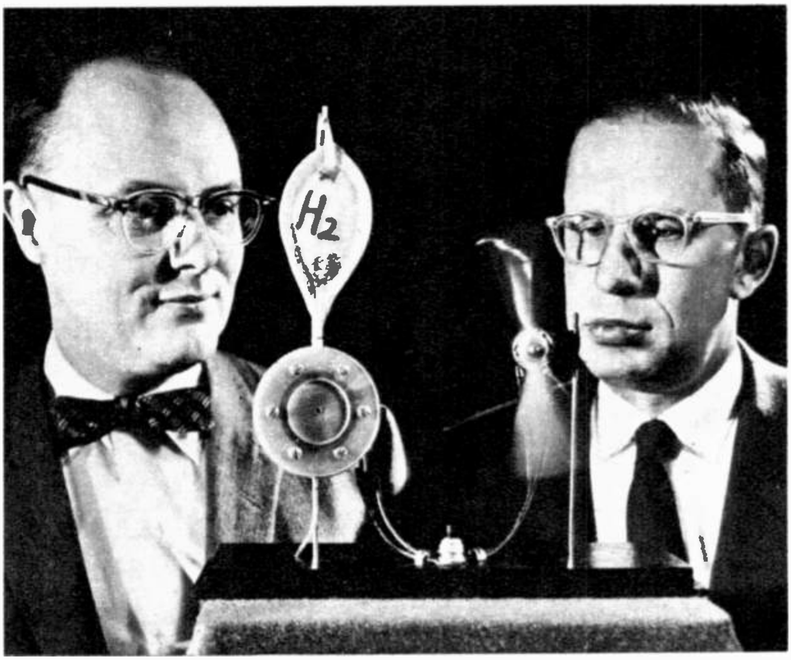


ture; (2) always connect the load before applying power; (3) never run the supply in excess of the rated continuous current for more than 10 or 15 minutes at a time; (4) if your funds permit, include a meter in the construction. Inexpensive meters such as the one shown are very helpful in keeping the equipment within rating. Going even further, a very useful addition would be a 0-10 volt DC meter connected right across C to meter the output voltage.

The filter capacitor C consists of two 2000 mfd capacitors in parallel; for further reduction of hum (there should be none noticeable), a third capacitor might be added in parallel.

PARTS LIST

C—Two 2000 mfd electrolytic capacitors 15 volt in parallel
R—Section of nichrome heater element wire (See text)
SR—Selenium rectifier 18 volt input, 14 volt output, rated at 4 amps continuous. (Available from Barry Electronics, 512 Broadway, New York, N. Y.)
SW—DPDT switch, neutral center position, rated at 6 amps 125 volts. (Philmore Mfg. Co., 130-01 Jamaica Ave., Richmond Hill 19, N. Y., type 226A)
T—Transformer, 117 volt primary with two center-tapped secondaries, 9 volts each side of center tap, connected in parallel as shown. (Available from Barry Electronics Corp., address above.)
M—0-10 ampere DC meter
Misc.—5"x9"x3" chassis (Bud AC-421), alligator clip, line cord, two binding posts.



Hydrogen in balloon reacts with air's oxygen to produce enough electricity in plastic cell to spin miniature propeller. GE research staffers look on.

electricity from air...

The Fuel Cell

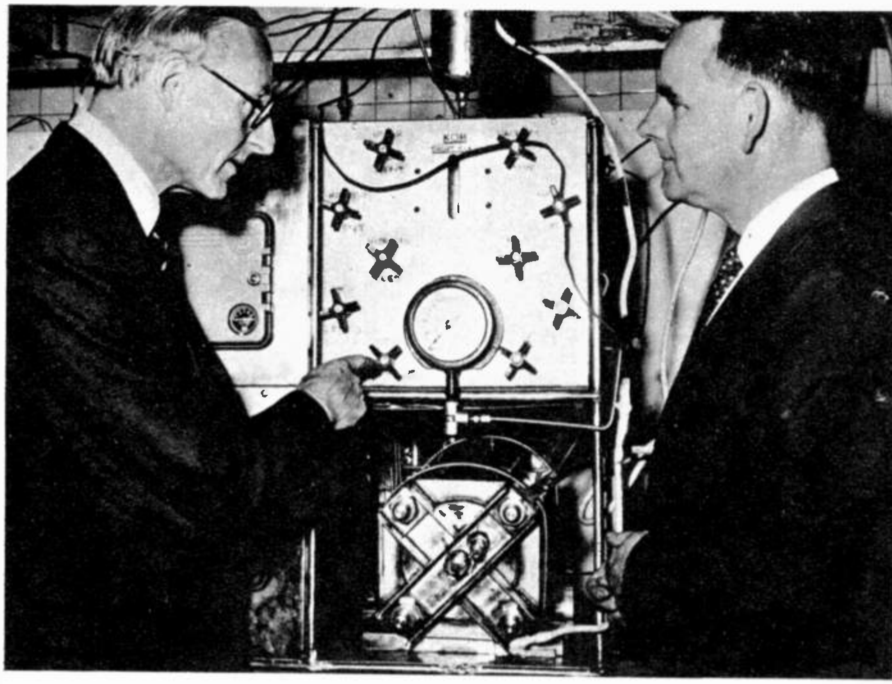
The life blood of electronics—electricity—is now being concocted directly from gaseous fuels.

Fuel cells, 1008 of them, power new Allis-Chalmers tractor. Propane and oxygen yield 15 kw.

THERE'S a fuel cell in your future. Dozens of scientists and engineers all over the world are racing to perfect this new way—that is also one of the oldest ways—of making electricity.

Within two years, highly efficient fuel cells should be generating the electricity needed in satellites and space probes to run communication and other electronic equipment.

In five years, electric vehicles such as fork-lift trucks will be powered by fuel cells. About the same time, fuel cells will be



English scientist F. T. Bacon, left, and colleague, examine a Hydrox fuel cell. It uses only hydrogen and oxygen to produce electricity without conventional engines or generators. The volatile hydrogen requires a control set-up larger than the fuel cell itself.

available to power remote ranches and unattended radio relay stations.

Will they be used to power autos? The experts believe there is a very strong possibility of this after 1970.

These predictions are substantiated by the following accomplishments:

- Recently, a British engineer, Francis T. Bacon demonstrated a fuel cell that operated a fork-lift truck.
- The Allis-Chalmers Co. showed an experimental tractor powered by a battery of 1008 small fuel cells. Without so much as a whisper from the power source, the 5270-pound tractor dragged a gang plow through a large field.
- Throughout the entire run of the Brussels World Fair, an American-made fuel cell kept a bank of lights glowing.

Many big corporations and the government are anxiously pushing fuel cell projects because these cells have several great advantages over other ways of making electricity. Let's look at them:

- *High efficiency:* Some fuel cells convert up to 70 percent of the energy pumped into them into electrical energy. This compares with 41 percent efficiency for the newest and largest power plant turbo-generators, and 35 percent for large diesel generator combinations.
- *Silence:* There are no moving parts.
- *No fumes:* The only waste products of most fuel cells is water.
- *Long life:* Some fuel cells have operated continuously for more than a year.
- *No heat necessary:* Some fuel cells operate at room temperature.

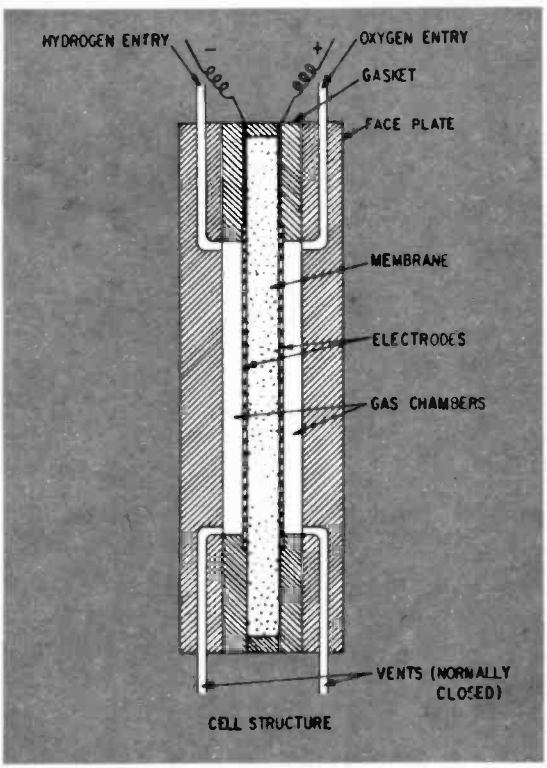
What is a fuel cell? Just mix two gases in a chemical solution called an "electrolyte." The energy they give off when they combine is immediately converted into electricity at special collection plates. There is no intermediate and wasteful heat stage, so the cell doesn't heat up of its own accord. The byproduct, usually water, is simply drawn off.

Since the fuel cell is so simple, it's reasonable to ask why it hasn't been perfected up till now. Scientists have certainly been plugging away at the fuel cell long enough. Sir Humphrey Davy talked about the fuel cell 150 years ago. Way back in 1839, Sir William Grove built a fuel cell powered by hydrogen and oxygen.

Most of the early researchers found

that their cells were quickly contaminated and soon stopped working. Extremely pure gases are needed, and purity means high cost. In addition, the favorite fuel, pure hydrogen, is dangerous to handle.

New knowledge of materials has spurred recent progress in fuel cells. Researchers at Lockheed laboratories in Sunnyvale, Calif., have developed ceramic-like electrodes made out of the rarer "transition metals," more familiarly known as the "rare earth metals." National Carbon Company researchers are using carbon for the electrodes and a potassium hydroxide solution for the electrolyte. General Electric scientists have developed a solid, plastic-like electrolyte in place of the liquids that most other researchers use. They claim that this will enable them to pack cells more densely into a given volume. The plas-



Here's a diagram of GE's fuel cell which uses plasticized electrodes instead of metal. Water is waste product. Unit is encased in plastic.

Speed and direction controls on tractor vary polarity and amount of current to 20-hp motor.

ticized material is said to pass electrons between the electrodes in much the same manner as the solid electrolyte in a dry cell.

All this talk of "electrodes" and "electrolytes" brings to mind the familiar dry cell and storage battery. After all, they also convert chemical energy into electricity. What's the big difference between the fuel cell and conventional batteries?

The big difference is in the *location* of the chemical energy. The energy in dry cells is stored in the electrodes, which are eventually consumed. In storage batteries, the energy is also stored in the electrodes. However, the chemical reaction that produces electricity is reversed when the storage battery is recharged, restoring the electrodes to approximately their original condition.

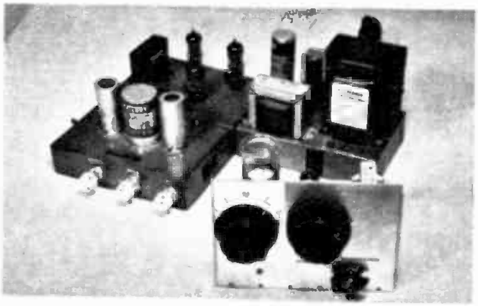
In the fuel cell the chemical energy is stored *outside* the cell in gas tanks. The electrodes *promote* the reaction, but are not eaten up by it. Therefore, they should last indefinitely.

The inventors of the various fuel cells each see their devices in different appli-

[*Continued on page* 120]

the E I Build-It Course-6

This month's project, combining theory with practice, is a regenerative detector for the SWL.



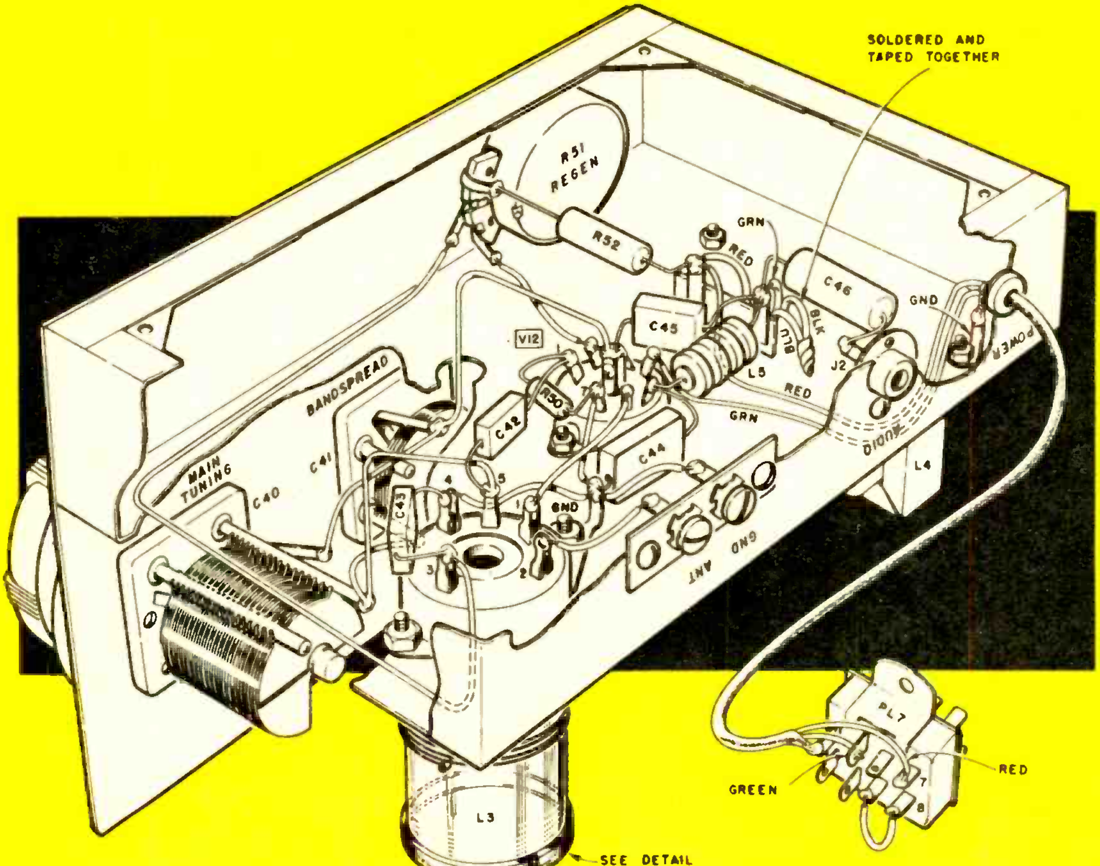
Unit may be built to plug into the previous projects in this series; in place of FM tuner.

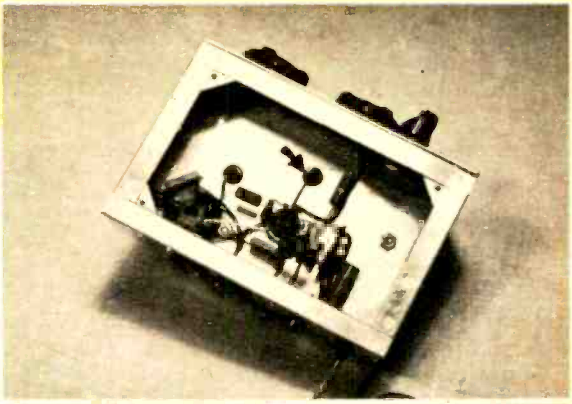
THE AM and FM tuners recently described in this series use the superheterodyne circuit, notable for its ease of tuning, sensitivity and selectivity. This combination of features has virtually eclipsed the *regenerative detector,* which previously enjoyed wide popularity. We are going to revive it here; it still has much to offer the electronic hobbyist.

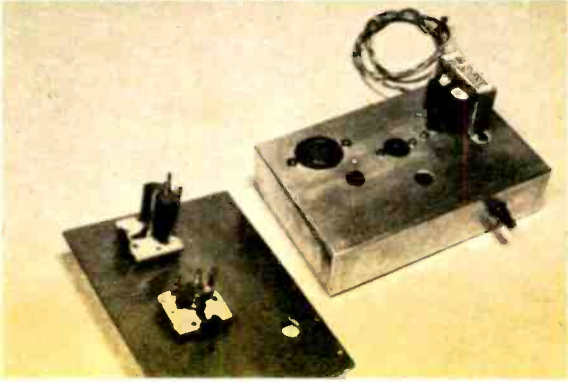
It can't be surpassed for performance versus amount of parts required (and low cost, too). Several manufacturers of Citizens Radio transceivers are using regenerative circuitry for this reason. Speak to old-timers in ham radio and there's a good chance that they've "worked the world with a regen."

The regenerative set shown here employs a single tube to

Frequencies are pencilled on white paper pasted behind main tuning knob (only lowest band shown). Use Bandspread for tuning individual stations.





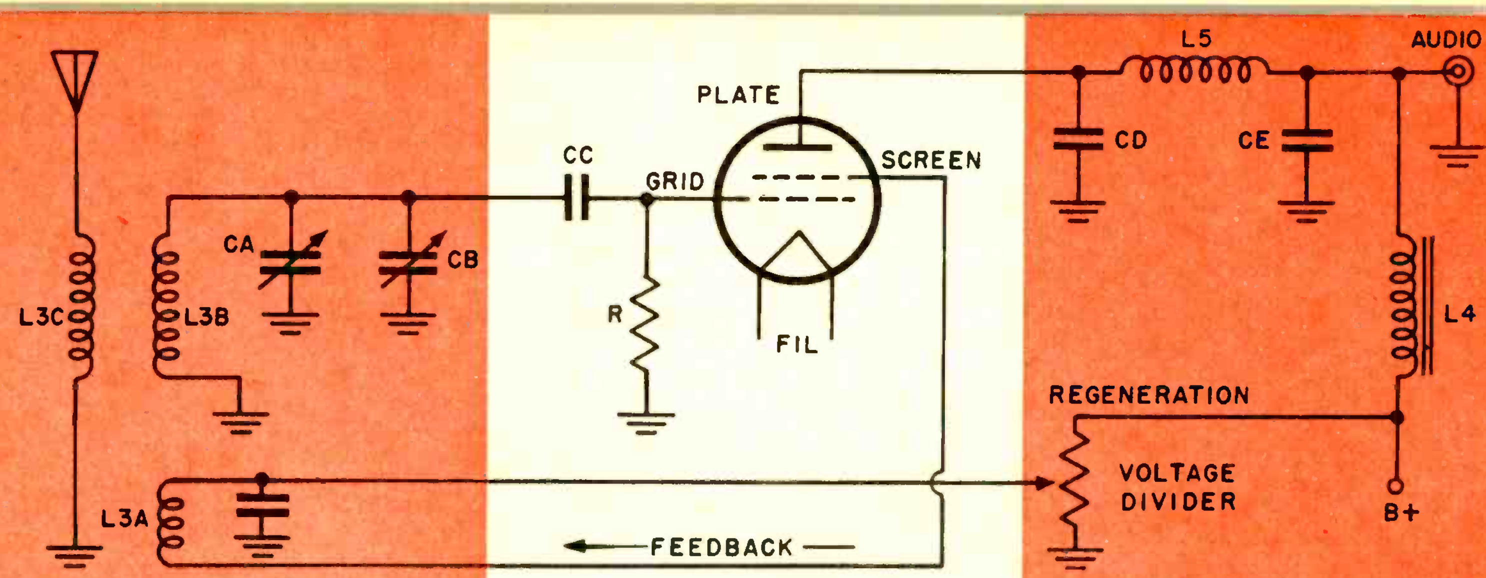


Above, left side of chassis is shown broken away to reveal detail of tuning capacitor wiring above chassis.

Underside view of model. Arrow near center points to ½" hole where ground wire from C40, C41 emerges.

C40 and C41 mount to front panel, which is fastened to chassis by R51 on one side, nut and bolt on the other.

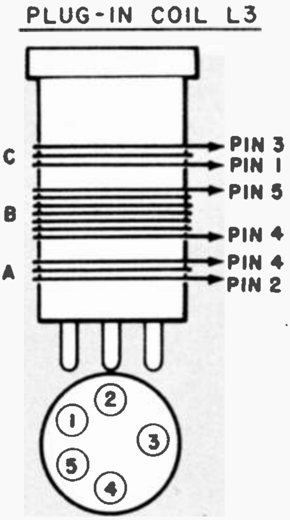
HOW THE REGENERATIVE DETECTOR WORKS



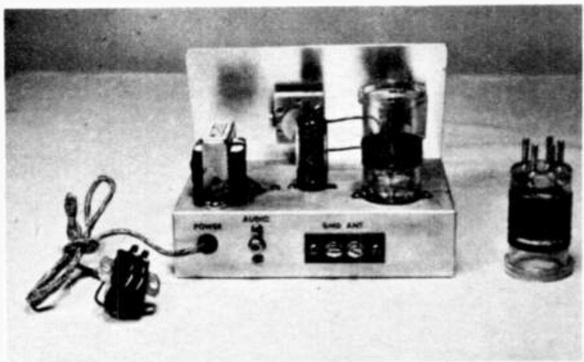
Signals are intercepted by the antenna and appear in the antenna winding (L3C) of the plug-in coil. They couple to tuning coil L3B. Variable capacitors CA and CB are across the tuning coil to resonate it and select the desired station. The slow tuning rate of CB serves to bandspread the stations. L3A is the tickler winding of the coil. It couples energy from the output of the tube back into tuning coil L3B to provide the regenerative action which greatly reinforces the original signal. Note that the feedback signal in the tickler is identical to the signal that has been selected by the variable capacitors and tuning coil except for one important difference: it is an amplified version of it since it has passed through the tube. All coils are wound on the same form.

Selected signal enters capacitor CC and the resistor R. They form a grid leak for detection purposes. Detection removes the negative half of the input signal, the first step toward converting it from a radio to an audio waveform. It works in the following manner: the signal drives the grid positive causing it to conduct electrons from the filament. They flow through resistor R and produce a voltage drop that makes the grid negative. CC blocks the passage of electrons back through the tuning coil; they can only "leak" through the resistor. The negative grid voltage is the operating point (or bias) that determines the portion of the waveform that will be amplified in the tube. Thus, only the positive pulses drive the grid sufficiently positive to permit electrons to flow in the screen and plate circuits.

Regeneration control is across the B+, its movable arm selecting out the desired voltage. This voltage is applied to the screen, through coil L3A thereby determining the amount of electrons attracted to the screen. If the arm is moved toward ground, the screen is made less positive and the amount of feedback is reduced. L5 with its associated capacitor CD and CE form a radio frequency filter. Here, the spaces between the RF pulses are "filled in," much in the same manner as the power supply filter described earlier in this series. The net result is an audio waveform, fed to the audio jack into which the earphones are plugged. L4 is an iron-core choke whose large inductance opposes low audio frequency passage.

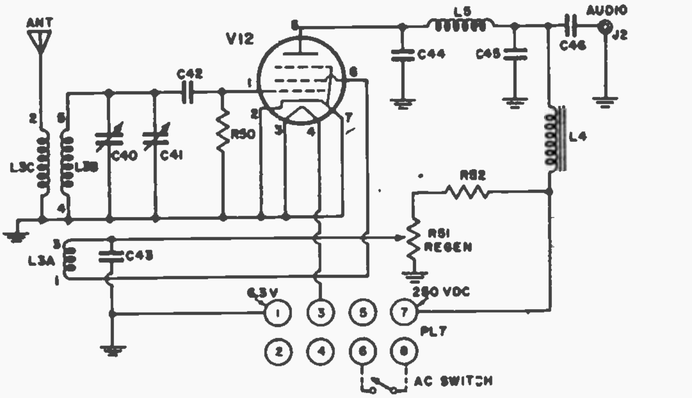


BASE PINS OF L3



Rear of unit reveals input and output. Two of the three coils are shown; one in its socket.

At left is coil winding guide. Pin numbers along side correspond to base pins of L3.



Schematic of detector. Pins 1 and 7 on PL7 show required voltages if an external power supply is used.

accomplish each function of receiving. It tunes radio signals in the antenna and supplies audio; sufficient to drive earphones at the output. Code reception is easily possible, too.

Consider this tube (for a moment) as a basic radio frequency amplifier. Impress a signal voltage on its control grid and amplification occurs in the plate circuit. This is because the large plate current flow varies with control grid fluctuations. But our aim is *maximum* amplification. This could be done by

[*Continued on page* 117]

PARTS LIST

(Part numbers continue from last month's project)

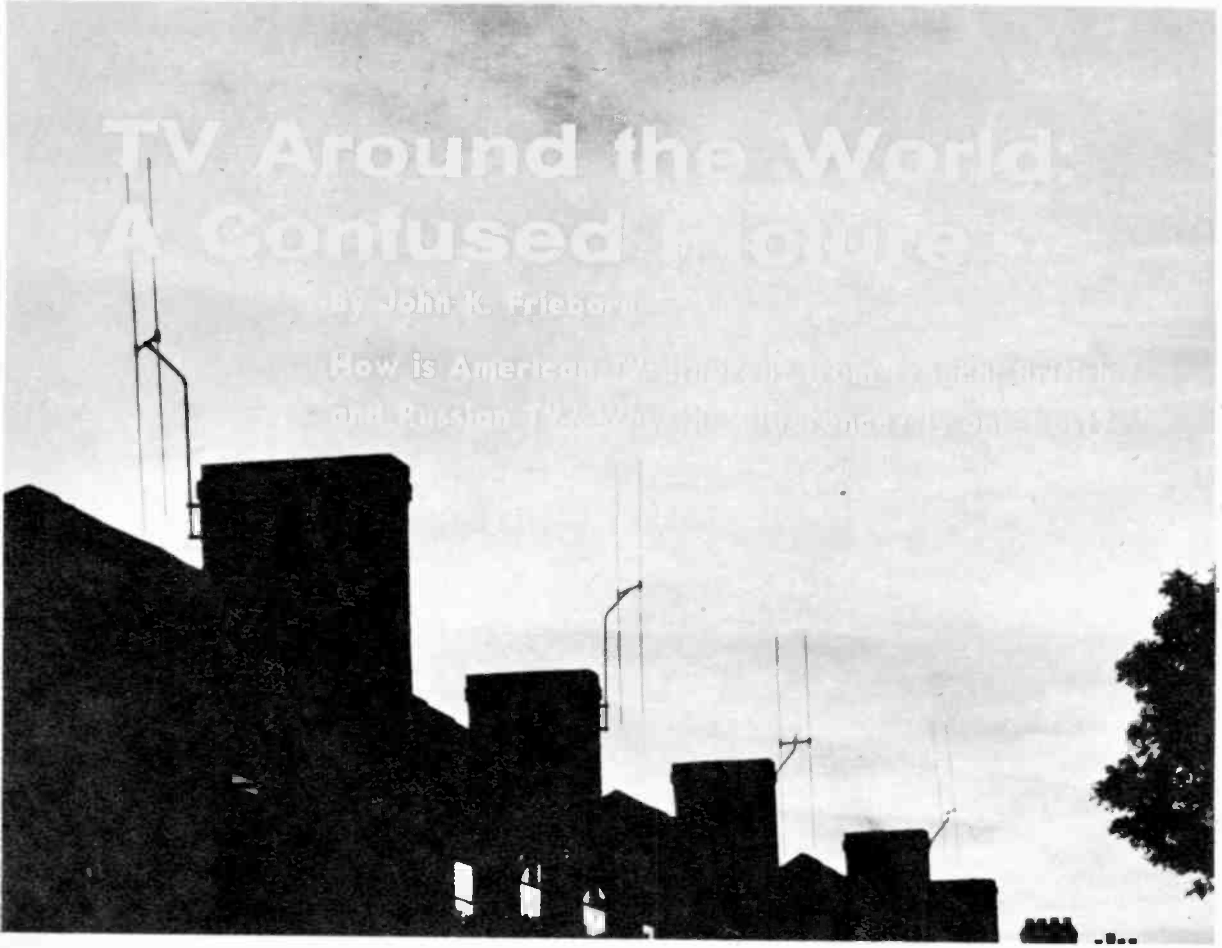
R50—220,000 ohm resistor ½ watt
R51—50,000 ohm potentiometer
R52—18,000 ohm resistor 2 watt
C40—140 mmfd variable air capacitor
C41—15 mmfd variable air capacitor
C42—100 mmfd mica capacitor 500 volt
C43,C44,C45—.001 mfd mica capacitor 500 volt
C46—.01 mfd paper capacitor 400 volt
V12—6BC5 tube
L3—Plug-in coil, #24 enamel wire closewound. Space windings approx. 1/16" apart. Wind three forms for following frequency coverage:

	1.8 mc-5mc	5 mc-12 mc	12 mc-20 mc
L1,L3	5 turns	3 turns	2 turns
L2	25 turns	12 turns	5 turns

L4—Audio choke. Use Stancor A-53 and wire as shown in wiring guide
L5—2.5 mh choke
PL7—8-pin chassis mount plug (Cinch-Jones P308AB)
J2—chassis-mount phono jack
Misc.—Aluminum chassis 4"x6"x1½" (Premier ACH-436), one 7-pin tube socket with centerpost, rubber grommets, #14 enamel wire, #24 enamel wire, three coil forms (Amphenol 24-5P), one standard 5-pin tube socket, one 2-lug terminal strip, 2-screw terminal strip for antenna-ground, 2-conductor shielded cable, scrap aluminum for front panel, knobs

TV Around the World: A Confused Picture

By John K. Frieborn



Rooftops in England: Notice that even the antennas are different. In U. S. we have horizontal polarization while English prefer vertical. No reasons given.

CAN you watch foreign programs on your television set? Could you use your set in another country? If visitors to the United States take home American sets, will they be able to use them?

Standard U. S. equipment may be used almost anywhere in the Americas. But elsewhere the owner of an American set would run into trouble. Even in Europe, a set made for one country may be just this side of worthless in another.

A variation in power line voltage is perhaps the first difficulty. In some Latin American and European countries the voltage is around 117, as in the United States. But many other countries use 220 volts. This problem is not confined to television and can easily be solved with a step-up transformer.

But the real problem, whether you take your TV set to another country or stay home and try to pick up foreign stations, is in the TV signals themselves. Channels may be on entirely different frequencies. Even if your set could be made to bring in the video signal of an overseas channel, the sound may not be along for the ride.

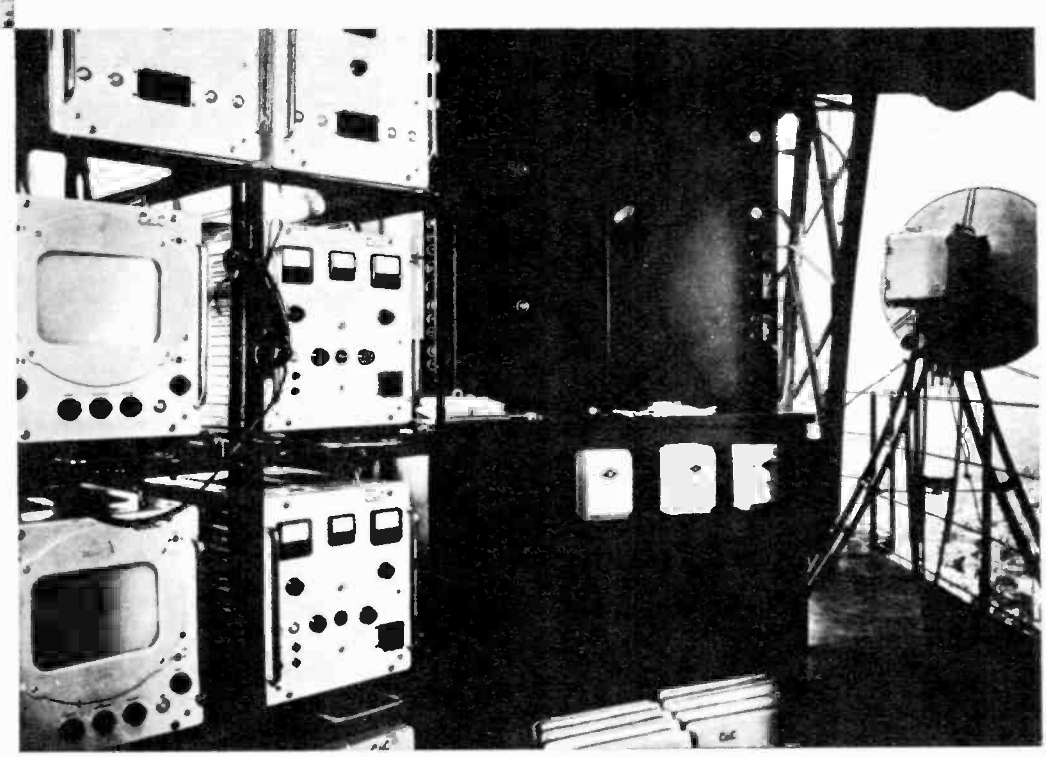
Chances are that video and sound carrier frequencies are not separated in the same degree as in standard U. S. TV.

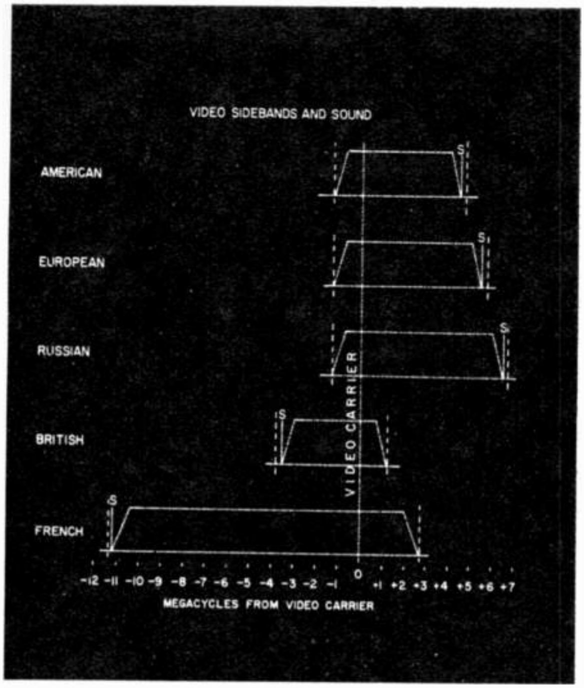
And the detail of the picture may be spoiled because your set does not have the kind of frequency response required by the

Number of horizontal scanning lines per frame varies in several systems. Number can make a difference in picture definition. Example: (L. to r.) 60, 400, 800 lines respectively.

Radiodiffusion-Television Francaise photos

Paris TV gets into provinces thanks to facilities atop Eiffel Tower. But American set couldn't get good signal even if it was within a mile because of 819 line scan, etc.





Amount of detail in a television picture is a function of bandwidth, but the wider the bandwidth, the fewer the number of channels available to the viewer. The trapezoidal sections represent bandwidths of the video signals. All video carriers are shown along the same vertical axis. The short, solid vertical line marked "S" represents the sound carrier. Broken lines are nominal edges of the channels. French have widest bands.

transmitted signal. Then too, it may not be possible to get a synchronized picture.

If you modify your set to take care of all these differences, you may get a picture which is fine except for one thing: It is like a photographic negative, dark where the original scene was bright and vice versa.

The parts of the radio spectrum available for television and FM broadcasting are fixed by international agreement. One set of bands is used in the Americas, slightly different bands in Europe and Africa, and a third variation in Asia and Australia. The USSR and its satellites use bands slightly different from those used by other countries.

Tuning *to* a channel would not necessarily be the same as tuning *all* of the channel in properly. U. S. television channels are 6 mc wide; others are 5, 7, 8, 9, or 14 mc.

U. S. TV channels have the sound carrier 4.5 mc higher in frequency than the video. Elsewhere in the world the difference is 5.5 or 6.5 mc. The British and French have depressed their sound *below* the video.

All of these differences in frequency arrangement within a channel require differences in video and sound circuits.

The vertical sweep frequency in a television set usually is the same as the local power line frequency, 60 cps in the U. S., 50 in some other countries. Two vertical sweeps are required to make one picture or frame, so there are either 30 or 25 frames per second. A TV set's vertical hold control usually has

[*Continued on page* 123]

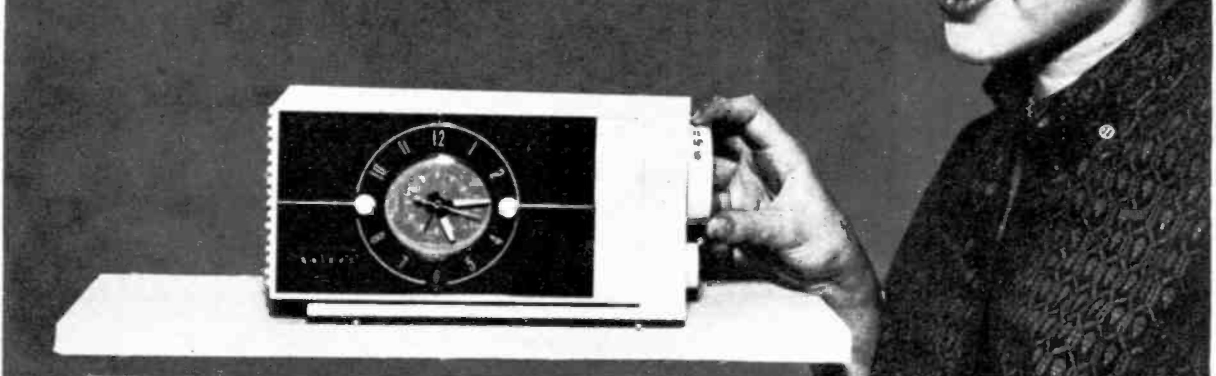
TV SCANNING STANDARDS

System	Frames Per Second	Vertical Sweep Frequency	Lines Per Frame	Horizontal Sweep Frequency
American	30	60	525	15,750
European	25	50	625	15,625
Russian	25	50	625	15,625
British	25	50	405	10,125
French	25	50	441	11,025
French	25	50	819	20,475

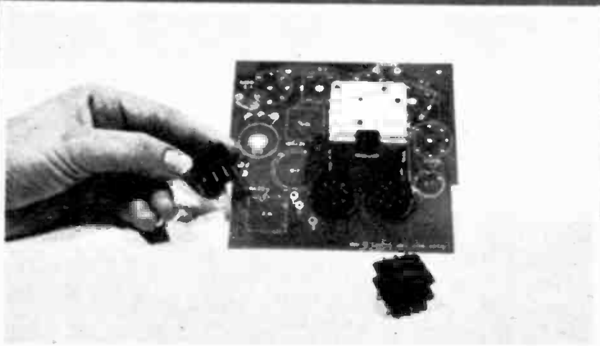
Henry and Me Electronic Handymen

E I reports on the

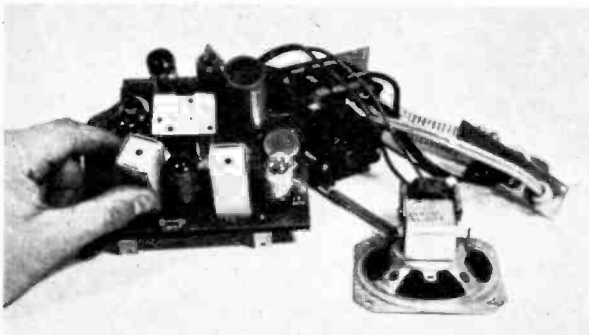
Knight - Kit Clock Radio



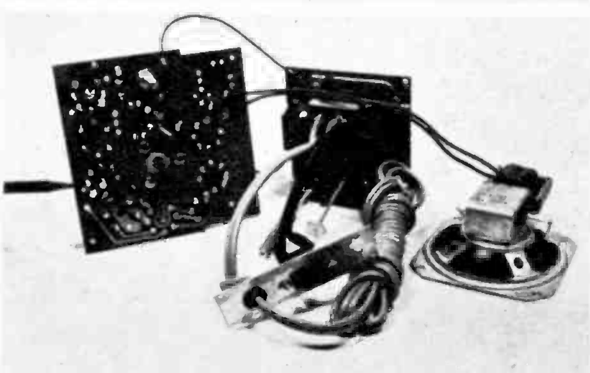
Tuning and volume controls are at right side of the cabinet. Clock and its timer controls are on the front panel.



Hand holds one of two plug-in modules containing resistors and capacitors. External wires are soldered to board.



At left an IF transformer is added to the top of the board where most of the larger components are mounted.



Component leads are soldered to the board's underside, left. Clock, line cord and speaker are visible next to it.

Plug-in modules, used in a kit for the first time, reduce this unit's construction time to two hours.

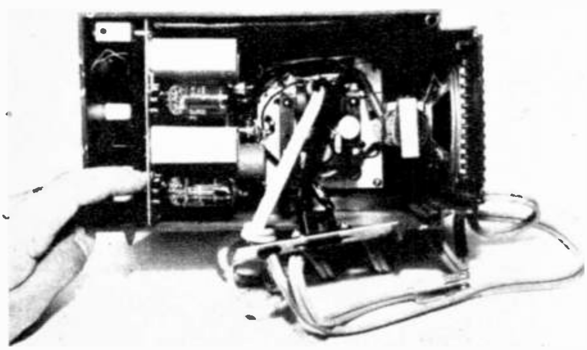
ALLIED Radio of Chicago is marketing a unique clock-radio kit. A conventional five tube superheterodyne circuit is assembled on a printed circuit board which utilizes two plug-in modules that contain most of the small parts—resistors and capacitors.

A soldering iron, cutting pliers and a screwdriver are all that are needed to assemble the set. Five tube sockets snap into place on the board, as well as the IF cans, oscillator coil and filter capacitor. Three screws secure the tuning capacitor to the board. The output transformer is mounted on the speaker frame and slides into place between two brackets moulded into the plastic cabinet.

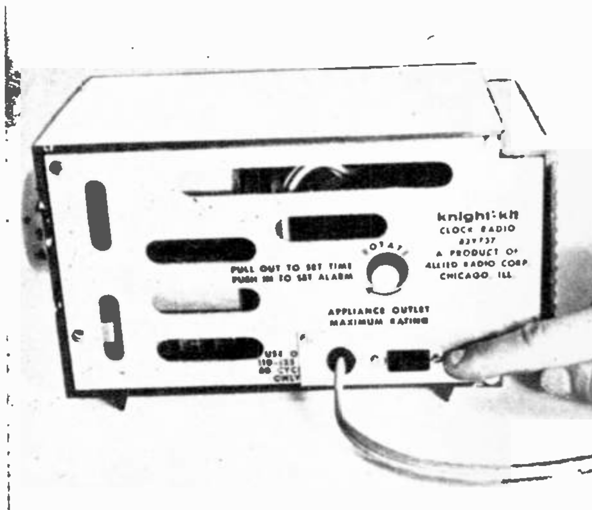
A Telechron clock and alarm is attached to the cabinet by four self-tapping screws. Any appliance that draws up to fifteen amperes can be turned on automatically at a predetermined time.

The instruction booklet is well written and the easy-to-follow drawings make errors almost impossible. Parts fit into just one designated spot, the entire kit requiring about two hours of construction time. The set operated perfectly without any adjustment to its oscillator or IF circuits. Slight trimming and peaking of the transformers can be done with a signal generator, but alignment by ear and a plastic adjusting tool is quite sufficient. Soldering the modules into the circuit is simple once the first "riser" is solidly in place.

The clock movement is rugged and the printed circuit should give many years of reliable service if the radio is not manhandled unreasonably. The kit sells for $24.95. –



Rear view of open cabinet. Note vertical mounting of the printed circuit board at left.



Rear cover in place. Finger points to AC accessory socket for controlling appliances.

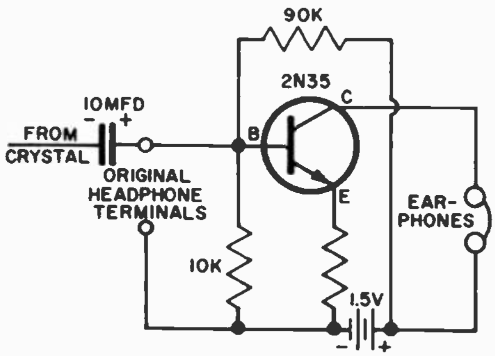
Electronic Brain

Have you any question on electronics? Send it in and the Electronic Brain will provide the answer.

Amplifier for Crystal Set

I have a crystal radio to which I would like to add a transistor amplifier. Can you give me the circuit for this?

Charles Miller, Tonawanda, N. Y.



The circuit for the additional transistor amplifier stage is given in the accompanying diagram. To make the connections, remove your headphones from the position indicated in your diagram and add the transistor stage as shown. This circuit has been thoroughly tested and can provide good amplification.

You will note that the .002 mfd coupling capacitor originally present in the crystal set has been replaced by a 10 mfd type. This is very important if you are to realize the gain this circuit can provide. We might also mention that it is much better to mount transistors in special sockets intended for them than to try to solder them directly into the circuit. They are easily damaged by heat. In addition, be sure to observe the battery polarity shown, otherwise the transistor can be ruined.

Hydrophones

Can you provide me with details concerning hydrophone systems including information on microphones, connecting cables, amplifiers, etc.? Can hydrophones be purchased commercially?

R. W. Szulewski, West Seneca, N. Y.

A hydrophone is an underwater listening device. Its principal application is that of an echo depth sounder in ultrasonic sonar systems; in wartime, of course, hydrophones have been used to locate submarines by the transmission of noise from their propellers through the water. Sound travels great distances through water due to the density of this medium.

Microphones for hydrophonic application must be thoroughly waterproofed. The waterproof housing requires careful design in that it must admit sonic or ultrasonic pulses without excessive loss due to boundary reflections. Any type of microphone may be used, provided that these specifications are fulfilled. A PM speaker with output transformer should make an excellent transducer, but such a unit would be extremely difficult to waterproof. Due to the fact that the transmission line from such a microphone is low impedance, any waterproof cable would be satisfactory to connect it through the water to the equipment above the surface. On the other hand, a crystal microphone would call for a shielded *and* waterproofed transmission line to the surface.

Either transistor or vacuum tube amplifiers may be used with hydrophones. The requirement is that the amplifier, regardless of type, have sufficient gain for the microphone being used. Generally, an input transformer is required to match a crystal microphone to the input of transistor amplifiers due to the differences in impedance, although some circuits showing direct connections have been published.

The only hydrophones now being sold commercially are the ultrasonic type used for echo depth sounding. Manufacturers of such equipment may be located by referring to the advertiser's index in publications such as Electronics, Electronic Industries, Electronic Design, etc.

Tape Recorder Interference

When my tape recorder is placed on record or erase, it produces a high-pitched whine at 930 kc on my radio. What causes this and how can it be corrected?

Stacey Jarvin, Alberta, Canada

Erasure of recorded material on magnetic tapes is accomplished by passing the tape through a high-frequency alternating magnetic field. To produce this field, the tape recorder contains a built-in oscillator that generally operates continuously at about 80 kc. When switched to "erase," the field produced by the oscillator's AC appears in the head and is applied to the tape.

When this signal causes interference with a radio, the trouble may be due to one of two causes:

(a) Harmonics may be feeding back into the radio via the AC power lines. If this is taking place, the effect can be spotted by connecting a 0.5 mfd capacitor across the AC input terminals of the recorder *as close to the recorder as possible*. Line feedback will be greatly reduced or entirely eliminated by this method.

(b) The signal may be radiating through the air directly to the radio. The remedy for this is thorough shielding (metallic) of the entire unit, grounding of the shield, and by-passing the power lines at the recorder as in (a).

TV Inputs

Can a microphone and phono input be installed on a television receiver?

Thomas Stanley, Renns, N. Y.

First you must identify the first audio voltage amplifier in the sound section of the receiver. This tube may be either a triode or a pentode and is usually located close to the power output tube that feeds the loudspeaker. For the easiest possible circuit connections, secure an open circuit jack or a standard phono jack with its shell grounded to the chassis. Run a *shielded* wire from the center terminal of the jack to the control grid (grid #1) of the previously located audio voltage amplifier. Either a crystal cartridge or a high-output crystal microphone should be used.

Your next step depends upon your location and the type of receiver you have. With the microphone plugged in, try the noise level by rotating your channel selector to an unused frequency. If the noise level is too high, remove the last i-f sound tube from its socket. This procedure cannot be followed with series-type tubes, however, since it will extinguish a whole string. In this case, a closed circuit jack that disconnects the audio discriminator or ratio detector from the voltage amplifier would have to be used. As the microphone or phono plug is inserted in this type of jack, it automatically disconnects the audio amplifier from the preceding circuit while it simultaneously connects the microphone to the control grid of the audio stage. Unless you are experienced at electronic wiring, this procedure is not recommended since it may disturb receiver operation.

400 Cycle Power Supply

Can I use surplus equipment designed for 115 volts at 400 cycles on 115 volts, 60 cycle line? If not, what changes must be made in the equipment?

Richard Lagerstrom,
Marine-on-St.-Croix, Minn.

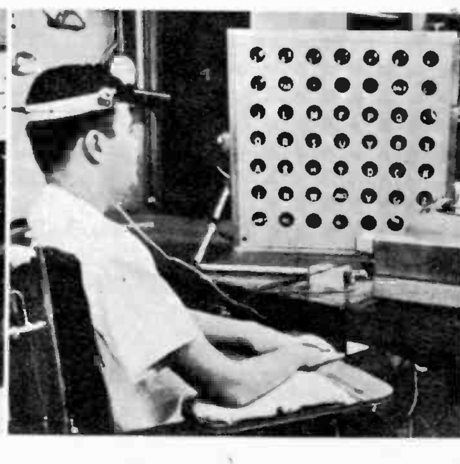
No, you cannot. Power transformers designed for 400 cycles have entirely different primary windings than those used on 60 cycles. The 400 cycle transformer would overheat badly soon after being connected to a 60 cycle line and its windings would pobably burn out.

It is necessary to replace the 400 cycle transformer with a 60 cycle type having the same voltage and power ratings. This data is usually obtainable from the specification plate on the equipment. In addition to this, the filter capacitor (s) and filter choke (or filter resistor) would have to be replaced since a 400 cycle ripple is much easier to remove than a 60 cycle ripple. If the original power supply was not "overdesigned," its filter components will be too small to do an acceptable job on 60 cycles. Increase capacitor size to at least 16 mfd and be sure that the choke is 10 henries or more. In the event that a filter resistor rather than a filter choke is used, its value for 60 cycles should be 10% larger than for 400 cycle operation.

E I Picturescope

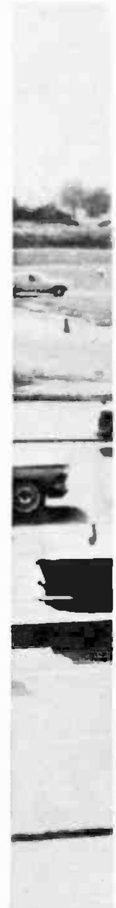
Back in 1929, a pretty girl who wanted to listen to a portable radio had to have a weightlifter for a boy friend. Nowadays, a pert lass, such as West German starlet Maria Perschy, can "lug" her own portable, in this case a Telefunken. Sports attire also seems to have dwindled over the years.

So you want a bank loan, eh? At lower left, unbeknownst to the applicant across the desk, London bank executive views his account and ledger records via Marconi closed circuit TV to determine how much credit to extend.



A transistorized radio which tunes the standard AM broadcast band is shown looped over the ear of lovely Karin Krause in Frankfurt, West Germany. In her hand is a second receiver with a wire antenna that can pull in stations within a 15 mile radius. A tiny battery supplies enough power for 150 hours of operation. Tuning this lilliputian unit is done by changing inductance of a tuning coil. They can be converted to receive other frequencies.

Typewriting, which normally requires considerable finger dexterity, may now be accomplished by handicapped persons who do not have the use of their hands. An electric typewriter has been hooked up with an "upright keyboard." Behind each letter or character on the board is a photo cell. In order to activate any given key, the patient simply aims a light strapped to his head at the appropriate "hole" in the board. Yes, it takes much practice.



Hy-Com receiver is installed in trunk of driver training cars, feeds speaker on dash. Antenna is pipe-like affair.

Radio Aids Driver Trainees

High school students learning to drive hear about their "road manners" through in-car radio setup.

Before the anxious Flint teenagers take to the road they must attend classroom lectures on driving safety, technique. Before heading for cars, left, they get some last minute instructions. Once on the course, right, they may hear teacher in tower say: "Slow down, 3!" "Turn left, 1."

Instructor in tower has a clear view of the entire range. The small Hy-Com panel allows him to talk to one, two or all three areas of the course at once.

BEFORE Flint, Mich., began its driver training program four years ago it had hit rock bottom in traffic safety for cities its size. Now Flint is number two. According to the latest fiscal figures available, driver training graduates were not involved in a single serious accident, and 95.5 percent had absolutely no traffic violations.

Delco Radio Division of GM has now joined the program with Hy-Com, their novel very low frequency radio communications system in which a single transmitter broadcasts messages to an all-transistorized in-car receiver. Hy-Com was designed primarily to allow authorities to inform drivers about speed limits, traffic conditions, exits—even historical points of interest. When the driver left the controlled road, he would return the receiver.

On the Flint driver training course, a permanent buried wire installation carries comments from a single instructor in an elevated tower to the would-be driver at the wheel. The instructor can communicate with any one of 20 drivers on the range and his messages are not heard beyond the immediate area.

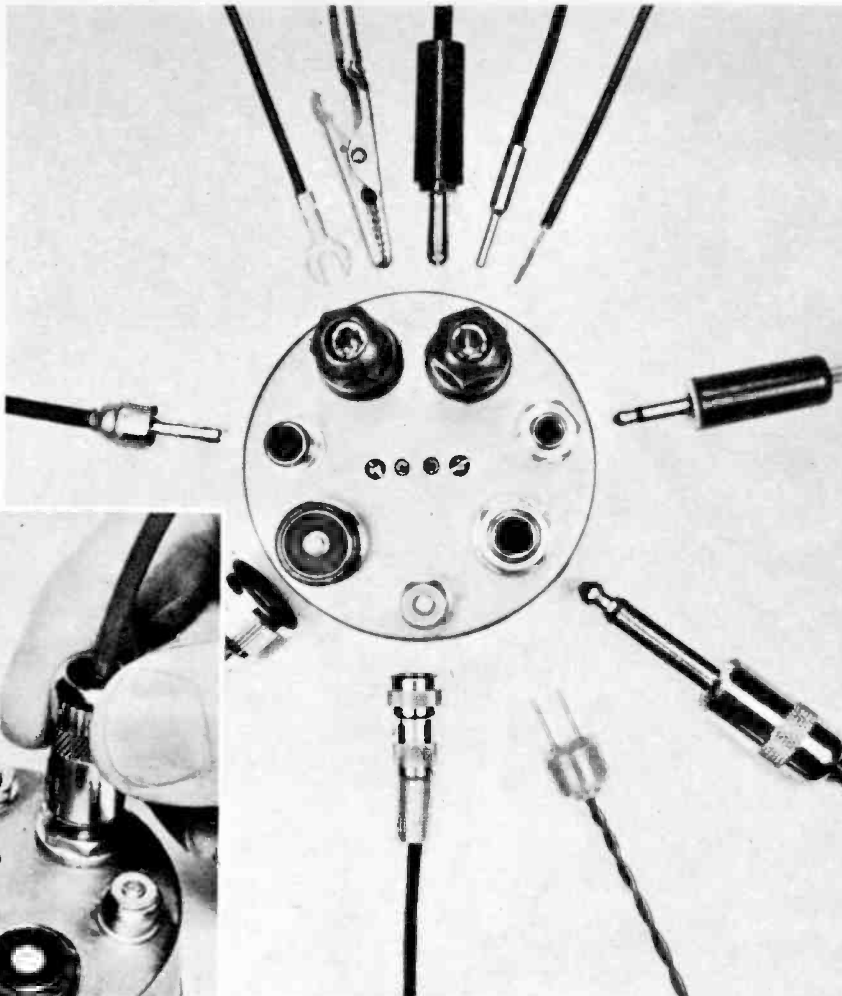


Photo above shows the various types of connectors that may be hooked together by means of the adapter at center. At left, a phone plug is joined to a pair of wire leads on binding posts.

Universal Cable Adapter

By Art Trauffer

Built into a typewriter ribbon case, this adapter permits over 50 combinations of cable connections.

WHEN the writer finished making this adapter he started to count the different combinations of connections that can be made with it, but when he reached 50 he gave up. Certainly, 50 is not the limit for this versatile and easily-made adapter. If you build one of these you will save much time and trouble when joining together various types of connectors in radio and electronics experimental and test work.

To provide a degree of shielding, the adapter is built in a 2½" by 1" metal container for a typewriter ribbon, but any similar metal container with a friction lid will do. The enamel coating on the outside of the container was removed with sandpaper and scouring powder.

The illustrations show how the two 5-way binding posts, and five of the jacks, are mounted in a circle on the friction lid. The "Tiny Jack" is screw-fastened in the center. The exact placement of the parts is not critical—just arrange them for convenience and good looks. Instead of drilling the mounting holes the required size, the writer found he could do a neater job by drilling small holes and enlarging them to the required size with rat-tail files. However, the four small holes for the "Tiny Jack" are easily drilled as required—use a No. 44 drill for the two mounting screws, and a No. 31 drill to clear the two pin holes in the jack.

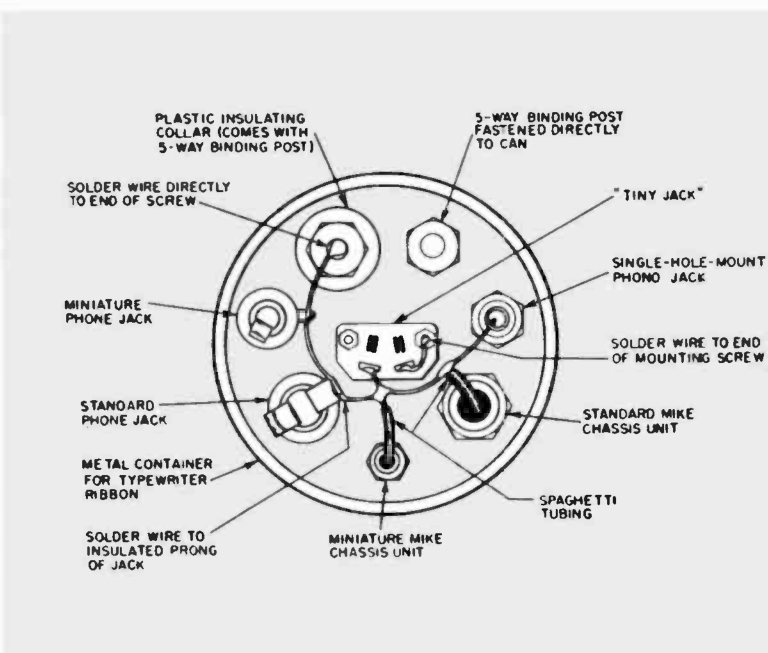
All of the parts are wired in parallel, and the wiring is simple because the "ground side" of most of the parts are automatically connected together when the parts are mounted onto the metal lid of the can. If the inside of the metal container is coated, be sure to scrape the metal clean at the places where the parts are supposed to contact the metal lid.

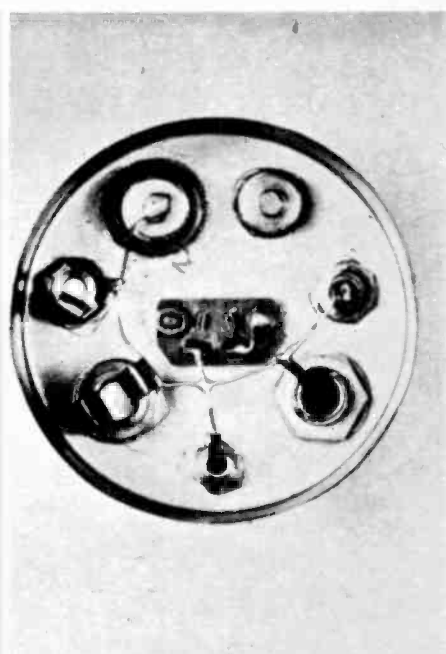
If your metal container isn't quite deep enough when the container is closed, simply raise the friction lid a little and then solder both parts of the can together with some solder spots.

PARTS LIST

2 5-way binding posts
1 single-hole mount phono pin jack
1 standard microphone chassis connector
1 miniature microphone chassis connector (Switchcraft)
1 standard open circuit phone jack
1 miniature phone jack
1 "Tiny Jack" (Lafayette MS-284)
1 round metal container with friction lid about 2½" wide and 1" deep. (Carter typewriter ribbon case or equiv.)
2 2-56 or 2-64 round head machine screws ¼" long with hex nuts for "Tiny Jack"
Misc.—Few assorted lockwashers, few inches #22 hookup wire

Drawing and photo show how parts are mounted and wired inside the case. Use #22 hookup wire. Note that one 5-way binding post has no wire connected to it since it grounds directly to case.





Braining Man Builds Better Brains

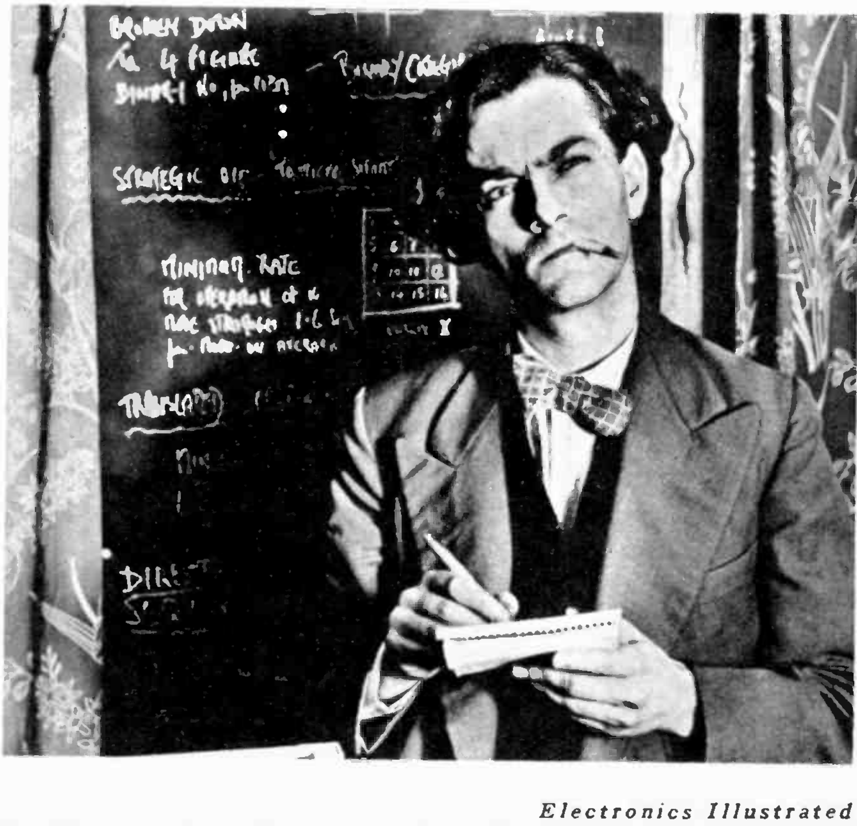
What does it take to be an electronics genius? Here is a profile of a young British candidate.

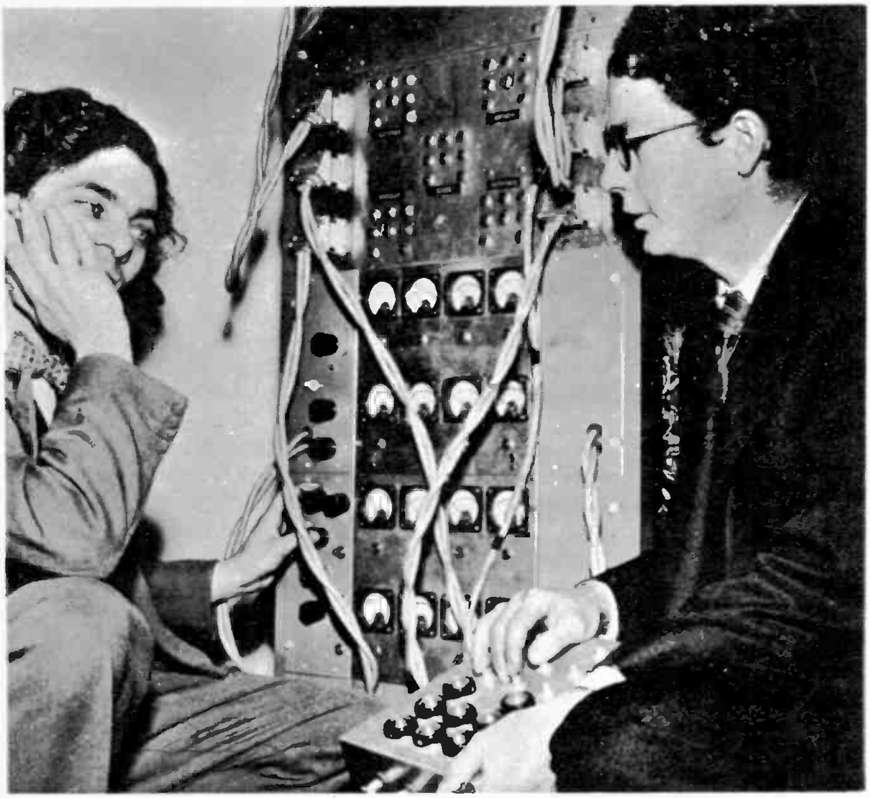
THE electronic genius of 27-year-old Gordon Pask hasn't exactly stood the world on its ear. For example, his first invention, a musical typewriter, was simply too expensive to run. Then came "Musicolor," a 70-tube, 100-relay brain designed to listen to music and automatically adjust the lighting of a stage or dance hall. A London theatre gave it a try and the critics were unanimous: "The show was a shambles!"

Undaunted Pask—his hair falling over his ears, his sad blue eyes rimmed with red—set about building an electronic brain so nearly human that it even has neurotic complexes. He has completed his masterpiece and has dubbed it "Eucrates I."

Exactly what is Eucrates I? Well, besides its many knobs, relays and vacuum tubes, it is a home- [*Continued on page* 125]

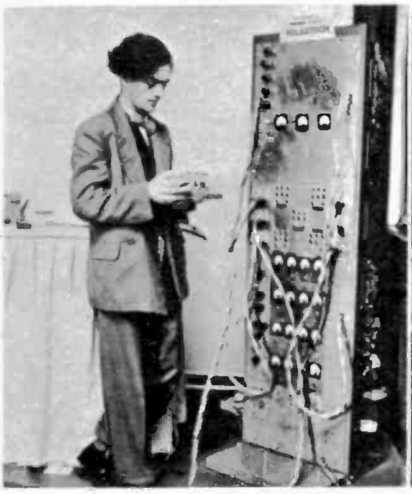
Deep concentration furrows the brow of Gordon Pask as his "mind's eye" works on some complex counting. On blackboard is matrix for his theories.





Pask and pal Wood, right, give Eucrates I a workout. Callouts under sets of bulbs read: Question, Answer, Stimulus, Clues, and finally Response.

Photos by BIPS



Eucrates I project, more successful than Pask's previous ventures into invention, is under the sponsorship of Solartron, a British industrial concern which is billing it as teaching aid.

Some sixty cigarettes a day seem to sustain Pask as he ponders the problems of electronic circuitry in his modest kitchen. Friends call him the "man who never sleeps," 6 hours in 3 days.

In the true do-it-yourself tradition, Pask makes his own chassis in the workshop of Systems Research Limited, an organization devoted to improving automation. He is co-proprietor.

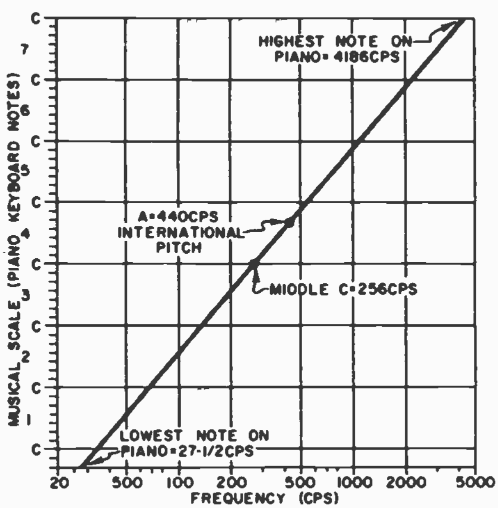
El's Hi-Fi Doctor. . . .

How Hi the Fi?

Hi-fi fans have been worrying for years about the frequency response of their outfits. They sink dough into woofers and cabinets for 30 cps output and for tweeters that go up to 16 kc. They buy special pickups and preamps for clean response above 10 kc and massive turntables to assure low (or no) rumble below 50 cps. They buy special test records, and then listen tensely, biting their lips and worrying about the response to harmonics in the 12 to 18 kc range.

Let's get back to fundamentals a bit: are we fixing up these hi-fi rigs so we can listen to matches being lit and keys being jingled? Or are we after music? Old-fashioned music with notes appeals to me and I don't have to have response from 20 cps to 20 kc within 1 db. Let's look at the notes of a musical scale in terms of frequency:

The lowest and the highest notes on the piano scale are 27½ and 4186 cps

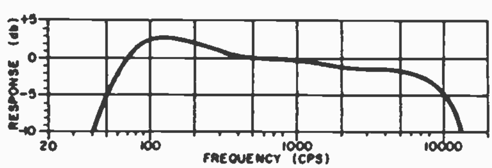


respectively. Did you ever see a piece of piano music calling for either the top or bottom note? Or even a note in the top or bottom octaves? I haven't and I've looked. The notes actually played on the piano range from 50 to 2000 cps.

What about other instruments? The bottom note on a string bass is 40 cps, and man alive, that is awful low. You hear it when the boys are tuning up. Maybe it's played sometimes but not often. At the top end, there are violin harmonics up to 5500, and the triangle, cymbals, and a few exotic noisemakers that go up to 6500 or so. Pretty rare, too.

Where do we get the notion that we need response from 10 to 20 kc? There is sound up there but it isn't music. It is key clicks, air hissing through mouthpieces, and fingernails hitting the music stands when pages are turned.

A hi-fi bug friend told me my outfit sounded wonderful—much better than his. He asked for my curve and was incredulous when I said I'd never run one. We ran one then and there with his own test record. Here is the curve we got:



The frequency response of my amplifier at the common advertising specifications of ±1 db was 70 to 2000 cps! The response was only 50 to 10,000 cps at —5 db! And there was an obvious peak at 100 cps.

My friend was appalled and wanted to help me fix up my rig. I reminded him that he thought mine sounded better than his own. "Yes," he said, "but that was before I saw your curve. Mine is much better than this."

and Clinic

Hi-Fi questions are all answered by mail. If of general interest, they will appear in this column.

Adjustable Crossover Net for Guitar

I need a dividing network that has a crossover of close to 175 cycles for use with two 8-ohm speakers. I want to use it with a guitar so that sound from 3 strings comes from one speaker and the sound from the other 3 from the other speaker. I want to be able to vary the crossover frequency. Also how can I convert the values for use with speakers of different impedances?

Robert John Damis, Elmont, N. Y.

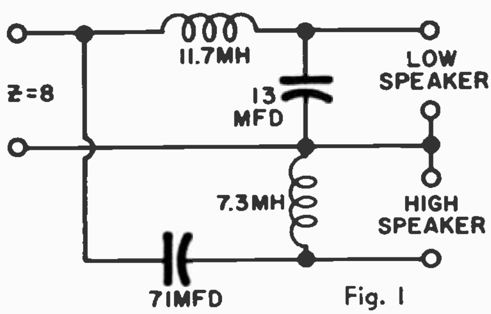


Fig. 1

Fig. 1 is a conventional m-derived dividing network for 175 cps and 8 ohm speakers. Because power is involved, we must use coils, and because impedance is low, the reactances must be small—hence balanced pretty carefully. This runs the cost up. I recommend you don't build this until you are sure of the frequency and the impedances.

I recommend instead that you build a breadboard high-impedance circuit (see Fig. 2) that has cheap parts which can be changed easily. Borrow or rent an extra amplifier and speaker, run your pickup signal into this net and feed the outputs into your own and a borrowed mike input. Try it out for pitch. This crossover is about 160 cps here. To increase the frequency, decrease either R's or C's, to make the pitch lower, increase either one. Play your guitar and try it out.

When your plans are firm, then you can go for the m-derived unit. The formulas are in many textbooks—MOTION PICTURE SOUND ENGINEERING* is one. Computing the values is easier than building it.

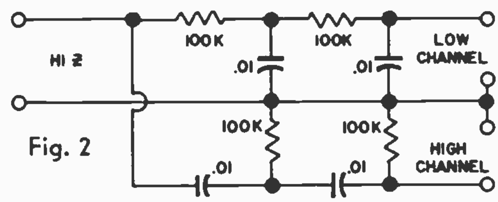
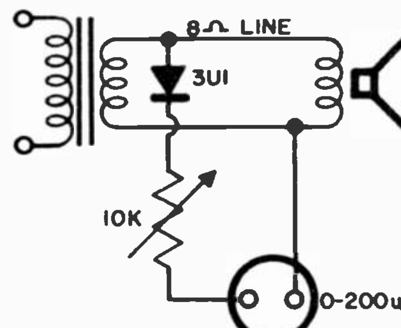


Fig. 2

Volume Indicator

Is there any way I can use a 0-200 DC microamp meter as a volume indicator on the output of an amplifier?

M. E. Harmon, Sandston, Va.



A 200-microamp meter is a voltmeter with a sensitivity of 5000 ohms per volt. You can hitch it across a speaker line with a diode to make the AC into DC and enough series resistance to make the total come to 5000 times the level you want to show full scale. For example, 5 watts in an 8 ohm line is 6.4 volts and total R should be 33K. Crystal impedances vary a lot. You could use a 3U1 here which has about 30K. I'd recommend a 10K pot in series so that you can adjust your indication to full scale on the loudest of your peaks.

*D. Van Nostrand, Inc., N. Y. 1938

Build a CB Beam Antenna

Continued from page 50

muffler clamp mounts the beam on mast.

Although not shown in the photographs, wooden dowels are inserted in each element and positioned below the muffler clamps. This prevents the clamp pressure from crushing the aluminum tubing. Also it will reinforce the splice if you are unable to locate 20 foot lengths for the elements.

A system of matching the coaxial cable transmission line to the antenna is necessary. This is accomplished with a device called a *gamma tube*. It is constructed from a 30-inch length of 1/4 inch aluminum tubing, similar to the type used in television antennas.

Start construction by cutting the three 20 foot lengths of one inch aluminum tubing to the dimensions shown. Mark the centers, slide the 12 inch wood dowel in each element, position and drill a hole each side of center for the muffler clamp studs. If you use two 10 foot lengths of tubing for each element, pin the element to the dowel for mechanical rigidity.

Next, prepare the gamma tube. The only point in this assembly that must be a good electrical connection is the junction of the gamma and the radiator element. Shine both points with steel wool before assembly. Mount the gamma tube to the element with the plumbers tape (or strap), and insulators, using 6/32 hardware. Join gamma tube to radiator with a 1 1/4 inch auto hose clamp.

The electrical connections are made by stripping back 20 inches of outer insulation and braid from the coaxial cable transmission line. Exactly 18 inches of the center conductor *with its insulation* is inserted inside the gamma tube. The copper shield braid is grounded to the *center* of the radiator with a sheet metal screw. Tape the opening in the gamma tube with Scotch #33 electrical tape, to keep the wire from moving and prevent moisture from entering the tube.

The elements can now be fastened to the boom. Once the antenna is assembled, you can determine the center of gravity and install the mast clamp at this point. Use 3 guy wires containing insulators, to support the mast.

BILL OF MATERIALS

3—20′ lengths of one inch aluminum tubing
1—10′ length of 1 1/2 inch thin-wall conduit
1—30 inch length of 1/4 inch tubing
4—1 1/2 inch muffler clamps
3—20″x1 1/8″ wood dowels
2—4″x1/2″ piece of polystyrene rod
4—1″x6/32 bolts, nuts, and washers
Mast as required (2 10′ lengths of "Swedge-Tube" recommended)
10″ plumbers tape
1 1/4″ hose clamp
Sheet metal screw and ground lug
Coax cable as required

Make Your Own Probe

Continued from page 56

non-critical. Strip back the cable insulation at the probe end as illustrated in the drawing. Couple the components together as compactly as possible and solder all joints securely. Support the leads of the crystal diode with a pair of pliers when soldering it in position.

A machine screw filed to a point makes an easily attached test prod as it can be secured to the probe housing with a nut. A deluxe test prod can be made by cementing an insulated plug tip into the probe housing.

Make all internal ground connections to the cable shield. Attach a short length of insulated wire to the shield for an external ground. This lead runs outside the probe housing and is terminated with an alligator clip. It must be clipped to the chassis of the item being checked for it completes the probe circuit.

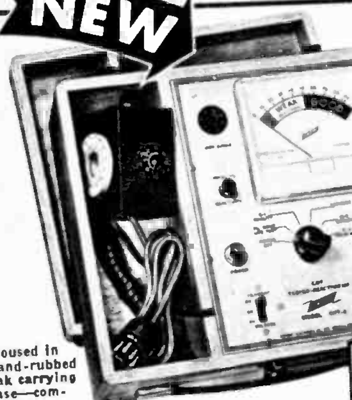
Terminate the output end of the probe's lead with fittings that match your test equipment. Make sure the cable braid is attached to common or grounded terminal if phone jack is used.

Chances are that sooner or later you will use your probe to trace a signal through a piece of AC-DC equipment. Assure your electrical safety when doing so by checking the polarity of the radio chassis. Reverse the line cord plug as necessary to put the chassis at ground potential.

Each type of probe has a specific purpose but may be used interchangeably for the more routine jobs.

SHIPPED ON APPROVAL

NEW



CRT TESTER-REACTIVATOR
Model CRT-2

NOW . . . a TESTER-REACTIVATOR really designed to test, repair and reactivate EVERY PICTURE TUBE MADE — whether black and white or color . . . with exclusive features never before found in picture tube testers.

1. **THE MULTI-HEAD (patent pending) . . . A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD** — A tremendous advance over the maize of cable and adapters generally found with other testers. Enables you to test, repair and reactivate every type of picture tube with greater convenience than ever before . . . 50 degree to 110 degree types from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base . . . even the very latest 7 pin base. A special color switch on the MULTI-HEAD enables you to test, repair and reactivate each of the red, green and blue color guns separately.

2. **WATCH IT REACTIVATE THE PICTURE TUBE** — You actually see and control the reactivation directly on the meter as it takes place, allowing you for the first time to properly control the reactivation voltage. This eliminates the danger of stripping the cathode of the oxide coating. It enables you to see the speed of reactivation and whether the build-up is lasting. You will see if the cathode contamination is too great and if the picture tube is too far gone to be reactivated.

3. **CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION** — Stronger than any found in other testers . . . high enough to really do the job — yet controlled to avoid damage to the picture tube.

4. **UNIQUE HIGH VOLTAGE PULSE CIRCUIT** — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.

5. **VISUAL LIFE TEST** — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter. The fact that your customer can see the results of your tests as you make them virtually eliminates resistance to picture tube replacement when necessary.

6. **TESTS, REPAIRS AND REACTIVATES SPECIAL LOW SCREEN VOLTAGE TUBES** — Many new type picture tubes use special low voltage of approximately 50 volts. The CRT-2 will test, repair and reactivate these types with the same thoroughness as the regular types with complete safety.

7. **SEPARATE FILAMENT VOLTAGES** — Including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.

8. **TESTS, REPAIRS AND REACTIVATES 'SF' PICTURE TUBES** — found in the newest Sylvania and Philco TV sets. These picture tubes have different base pin connections than standard picture tubes and there is always an element of risk that the tube may be burned out when tested with ordinary picture tube testers. The CRT-2 is designed to accommodate this new base pin arrangement and will test the tube with no danger of damage.

Housed in hand-rubbed oak carrying case—complete with MULTI-HEAD*

Model CRT-2 57^{50} Net

TERMS: $13.50 within 10 days. Balance $11 monthly for 4 months.

The CRT-2 steps in and solves the limitations and shortcomings of present day CRT Testers. Unlike ordinary CRT testers that keep entering the field with a limited range of operation, the CRT-2 employs a new brilliantly engineered circuit designed to test, repair and reactivate every black and white or color picture tube made. The CRT-2 eliminates the guesswork and risk that until now, has always been present when a picture tube is reactivated. It accomplishes this by providing perfect control of either the 'Boost' or 'Shot' method of reactivation.

THE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

TEST
- for quality of every black and white and color picture tube
- for all inter-element shorts and leakage up to one megohm
- for life expectancy

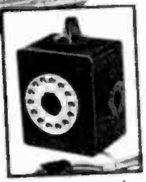
REPAIR
- Will clear inter-element shorts and leakage
- Will weld opens between any two elements in the tube gun

REACTIVATE
- The unique controlled 'SHOT' (high voltage pulse) method of reactivation provided by the CRT-2 will restore picture tubes to new life in instances where it was not possible before. Furthermore the high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse.
- The 'BOOST' method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will improve definition, contrast and focus greatly and add longer life to the picture tube.

ADDITIONAL FEATURES

• Employs the time proven dynamic cathode emission test principle • Large 4½" meter with heavily damped movement for smooth action, accuracy and long life • Filament continuity is shown on a separate glow indicator • An easy to read instruction manual contains all the latest testing information on old and new type picture tubes • Housed in handsome hand-rubbed oak carrying case with special compartment for MULTI-HEAD and line cord. • Provides separate shorts test for each element in the picture tube

*patent pending



IN-CIRCUIT CONDENSER TESTER
Model CT-1

Here is an IN-CIRCUIT CONDENSER that DOES THE WHOLE JOB! The CT-1 actually steps in and takes over where all other in-circuit condenser fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.

in-circuit checks:
- Quality of condensers even with circuit shunt resistance . . . (This includes leakage, shorts, opens, intermittents)
- Value of all condensers from 200 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:
- Quality of condensers . . . (This includes leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- High resistance leakage up to 300 megohms
- New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for ever greater accuracy
- Isolated power line
- Housed in sturdy hammertone finish steel case . . . comes complete with test leads

Model CT-1 34^{50} Net

TERMS: $9.50 within 10 days. Balance $5 monthly for 5 months.

EASY TO BUY IF SATISFIED – *see order form on facing page*

Milt Kiver on Probes

Continued from page 55

RF Probes

RF or high-frequency probes enable VOM's, VTVM's, and oscilloscopes to be employed in higher frequency circuits than they could ordinarily without such probes. Basically, the RF probe is a detector which rectifies the high-frequency signal. When such a probe is designed for a VOM or VTVM, a rectified output voltage proportional to the RF input voltage is desired. Since most RF voltages for which this type of probe is to be employed possess essentially a sine-wave form, the rectifying circuit in the probe is of the half-wave variety. See Fig. 2. The voltage developed by this rectifier is then passed through a long time constant filter and applied to the input circuit of the VOM or VTVM.

In using this probe for signal tracing, the probe is touched to the grid or plate of each tube and the resulting DC voltage noted on the VOM or VTVM. If you start at the grid of a stage and then go to the plate, there should be a noticeable increase if any amplification is occurring. By dividing the indication obtained at the plate by the voltage obtained with the probe at the grid, the stage gain can be quickly computed.

When an RF detector probe is designed to be used with an oscilloscope, it employs a slightly modified rectifier circuit. See Fig. 3. The basic difference is the much shorter time constant of the filter network. Thus, this probe will not only make available the rectified DC, but also any modulation that the signal may contain.

Peak-To-Peak Probes

The output of an RF probe can be increased by employing a voltage doubler arrangement. See Fig. 4. Two crystal diodes are employed, one conducting during the positive half cycle of the applied wave while the other conducts during the negative half cycle. The input is applied in like measure to each diode; the outputs are in series aiding.

Operation of the circuit is relatively simple to follow. During the half cycle when terminal A is positive with respect to terminal B, crystal CR1 will conduct and charge capacitor C1 to the polarity indicated. C1 will attain the peak value of this positive half cycle. A DC voltage equal to this peak value will appear across resistor R1, with the top end of R1 negative with respect to the bottom end. During the next half cycle, crystal CR 2 will conduct, charging capacitor C2 to the polarity indicated. This voltage across C2, equal to the peak value of the negative half cycle of the applied voltage, will appear across R2. Polarity of this voltage will make the top end of R2 negative with respect to the bottom end. Since the voltages across R1 and R2 are in series aiding, the output voltage will be equal to the peak-to-peak value of the applied signal.

Low-Capacitance Probes

Low-capacitance probes are employed with an oscilloscope when it is desired to view high-frequency waveforms in high-impedance circuits. For example, TV sync signal tracing. These sync waveforms possess a steep-sided, square-wave form with a good many high-frequency components. If the input of the probe contains a fairly high capacitance, it will load the circuit down and alter the shape of the sync pulses. Thus, instead of seeing the desired pulse, what you will see on the oscilloscope is a distorted version of it, Fig. 5.

The basic circuit of a low-capacity probe is shown in Fig. 6. It contains two components, a small trimmer capacitor with a high-valued resistor shunted across it. If we consider the capacitor first, we see that it is in series with the capacitance of the cable and the input capacitance of the oscilloscope. See Fig. 7. When we place the probe end (and the associated ground lead) across a point in a circuit, Cp and (C1 + C2) are in series with each other. The total value of two capacitors in series is less than the smallest one. Equation-wise, this can be expressed as:

$$\mathrm{Ct} = \frac{\mathrm{CP} \times (\mathrm{C1} + \mathrm{C2})}{\mathrm{Cp} + (\mathrm{C1} + \mathrm{C2})}$$

[*Continued on page* 117]

Superior's New Model 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

Model 77—VACUUM TUBE VOLTMETER. . Total Price $42.50
Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

Specifications

• DC VOLTS — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • AC VOLTS (RMS) — 0 to 3/15/75/150/300/750/1,500 volts. • AC VOLTS (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts. • ELECTRONIC OHMMETER—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • DECIBELS: —10 db to + 18 db + 10 db to + 38 db. + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • ZERO CENTER METER — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

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AS AN ELECTRONIC OHMMETER:

Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

AS AN AC VOLTMETER:

Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

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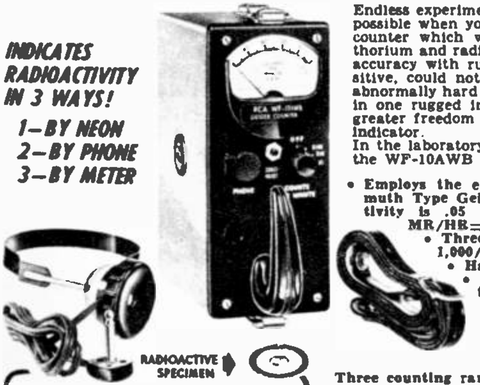

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- Handy reset button.
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- A radioactive specimen is included for instrument checking and experiments.
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RCA Radiation Counter
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SPECIFICATIONS

Three counting ranges are available
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Comes with complete set of batteries, carrying strap, headphone, radio-active specimen and A.E.C. booklet Only **$47.50**

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- Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc.
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Just read the following partial list of contents: What is electricity? • Simplified version of Ohms Law • What is wattage? • Simplified wattage charts • How to measure voltage, current, resistance and leakage • How to test all electrical appliances and motors using a simplified trouble-shooting technique. • How to trace trouble in the electrical circuits and parts in automobiles and trucks.

Model 70 comes complete with 64 page book and test leads

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TEST ANY TUBE IN 10 SECONDS FLAT!

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(1) Turn the filament selector switch to position specified. (2) Insert it into a numbered socket as designated on our chart (over 600 types included). (3) Press down the quality button—

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FEATURES:

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- ☐ Include Model 82A. Picture Tube Adapter at $5.50

New Tiny Tape Recorder

Continued from page 37

2¼-inch speaker, there is an output socket for attaching an external speaker. The amplifier has six transistors and the unit has a midget-sized ammeter which indicates recording level and also serves as a check on the condition of the battery. Yashica, Inc. is at 234 Fifth Avenue, New York 1, N. Y.

The Japanese Transi-corder TR 100 also has six transistors, but in addition to being battery-operated (9 volts), it has an AC switch so that it can be used with ordinary house current. There is a remote control switch for AC use. Changing the speed from 1⅞ ips to 3¾ ips is accomplished mechanically by simply sliding off an external capstan sheath, thereby reducing the size of the drive capstan (increasing the speed). A tiny but very sensitive meter monitors the recording level and also can be used to read battery voltage. Accessories to the Transi-corder include a small induction coil designed to be hung over the cradle prongs of your telephone. There is no beeper, as required by law, so we tried it out by recording telephone weather reports. The playback was extraordinarily good. Nippon Sound Equipment Co. makes it; it is distributed by Toyo Menka Company, 2 Broadway, New York, New York.

The American manufacturer, Mohawk Business Machines, makes a tiny tape recorder called the Midgetape 300. Similar machines appear under other names, such as Lafayette's "Transicorder" and the "Vanguard Midget." Depending upon who you buy it from, the price varies from $189.50 to $249.50. The main feature of the Midgetape is its weight: Three pounds. It records only at the 1⅞ ips speed and uses special cartridge-enclosed reels. It doesn't have a power rewind nor recording level indicator. There are four transistors in the circuit.

The British-made "Fi-Cord" and the Swiss-made "Stellavox" are very similar. In fact, they were both designed by the same person—Swiss engineer Georges Quellet. The half-track tapehead was engineered to NARTB specifications. While the Stellavox operates only at 7½ ips, the Fi-Cord also provides the 1⅞ ips speed. Frequency response up to 14,000 cps are claimed for these units. You can record approximately 10 minutes in each direction at 7½ ips. The four 2-volt batteries that power these recorders can be recharged with a small accessory charger. The Fi-Cord is $330 from Kingdom Products, 514 Broadway, New York, N. Y. The Stellavox sells for $399 from Electronics Applications, Inc., 194 Richmond Hill Avenue, Stamford, Conn.

Also available from Electronic Applications is the Nagra III, another Swiss instrument that is the super-duper granddaddy of all small tape recorders. The price is a clue: $945. And they're not kidding! It has no less than thirty transistors and operates off several types of batteries, or AC.

The "Hi-Delity" trade name appears on two small tape recorders, the model TR401B and the TR-403. The 401B, which lists for $159.50, has a single-lever operation for "play," "record" and "rewind." Without a speaker, tapes can be monitored through earphones. An extension speaker costs $24.95. You get 34 minutes of half-track recording time at 3¾ ips from this four-transistor job. Ten penlight cells (four for the amplifier and six for the motor) make up the power supply.

The model TR-403 ($199.50) has a built-in speaker, an AC adapter, remote control switch, two speeds (3¾ and 1⅞ ips), and weighs five pounds without leather case. An extension speaker can be plugged in. There are six transistors in the circuit, and all power comes from the same 10 penlight cells as are in the lower priced unit. Both Hi-Delity models are available from Petely Enterprises, Inc., 300 Park Avenue South, New York 10, New York.

The two-speed (1⅞ and 3¾ ips) Steelman "Transitape" weighs eight pounds and handles the standard three-inch tape reels. Equipped with power rewind, it draws its power from 13 Mallory batteries. There are a total of seven transistors in the circuit. List price: $199.50 from Steelman Phonograph &

Radio Co., Mount Vernon, N. Y. A telephone pickup is included.

Phono-Trix Mark II and Mark III tape recorders are from West Germany. The Mark II ($79.95) has a sliding switch which controls tape speed from 1-8 ips, while the Mark III ($99.95) is available in either the 3¾ ips or 1⅞ ips speeds. There is a built-in speaker on both models and both operate from four "D" cell flashlight batteries. A variety of accessories, including an AC adapter, can be had for the Mark III. Matthew Stuart & Company, 353 West 54th Street, New York 19, N. Y., handles these units.

The Austrian-made Stuzzi Magnette is a seven-transistor push-button unit that sells for $269.50. Featuring two speeds (3¾ and 1⅞ ips), the power source is four Burgess 532 batteries. It is distributed by Ercona Corporation, 16 West 46th Street, New York 36, N. Y.

Reeves Equipment Company makes the "Pocketape," weighing exactly two pounds and small enough to be slipped into a shirt pocket. It is also supplied in three speeds to 7½ ips. Price: $349.50 from Reeves, 8 Third Avenue, Pelham, N. Y.

Loran Lights the Way

Continued from page 48

used by navigators on shipboard or aircraft performs like an ordinary radio receiver, but delivers the output to a visual indicator rather than to a loudspeaker. It is also designed to receive pulsed signals. The indicator is essentially an "electronic stop-watch" capable of measuring, in microseconds, the difference in times of arrival of the signals from the paired stations. Horizontal traces, or "lines" of light on the screen of a cathode ray oscilloscope form the equivalent of the dial of a watch. A vibrating quartz crystal is the balance wheel, and circuits known as "dividers" or "counters" take the place of gears.

LORAN has proven so accurate and reliable as a navigation aid that it is also being used for speed trials of new ships.

In one of its trial runs, the *SS United*

States traveled a 53-mile course in the Atlantic established along the baseline of the LORAN pair of Nantucket and Cape Hatteras. The maximum error for the speed determination in the run was figured to be less than one fourth of one percent!

Go aboard almost any sizeable fishing boat today and you will find a LORAN receiver. Trawler nets are towed for approximately an hour and a half, then pulled onto the deck and emptied. If it is a good haul the skipper will want to travel exactly the same path again. And, with LORAN, he can. By taking a fix at the beginning of the tow, and another fix when the nets are hauled in, the exact run can be plotted on a chart and the boat can follow the same course.

Air-France, after several years of experimenting, reports the successful use of multi-reflection signals from Nantucket and Cape Hatteras on its regular flights between Dakar and Recife in Africa. That means that transmission distances of more than 3,500 nautical miles are involved.

Flash Your Photofloods

Continued from page 46

close (or the external switch is pressed). Since there are "holding" contacts on the relays, the lights will stay on full brilliance until released by the "Reset" button, and if the shutter opens 20 milliseconds after contact is made, the lights will be up. This unit cannot be used with "zero" delay shutters at high speeds of 1/100 second (10 milliseconds) or above, but can be used at slower speeds, such as 1/10 or 1/25 second, if compensation is made on the exposure meter.

The unit provides for up to four lights (either No. 1 or No. 2 photofloods), and has individual switches (SW1, SW2, SW3 & SW4), for each light.

When the unit is turned on, and the four individual switches are in the "Dim" position, voltage for the bulbs is fed through the upper side of the relay contacts and through a high wattage resistance. The cheapest form of such resistance is the ordinary screw-in type of heating element, one of which is used for 1 or 2 bulbs, and two in series for 3 or 4 bulbs. The switching of these resistances is done with the SW6.

Then the two shutter synchronizer contacts (or the solenoid release button) close, the relay is energized by the battery voltage and the resistance is bypassed allowing full voltage to reach the bulbs. One set of relay contacts continues to supply battery voltage to the relay coils, holding the relays closed until the voltage is disconnected by pressing the "Reset" button (SW7). In the case of using a solenoid, this feature is eliminated since the relay control is manual and can be held closed as long as desired.

The switching of this latter function and the selection on control sockets is done by the "Sync Selector" switch (SW8). The "Power" switch (SW5) closes the circuit of both the battery voltage and line voltage.

All wiring in the lamp circuits is done with heavy-gauge wire, not less than No. 12, and the switches used should be heavy duty.

If it is ever contemplated that more than two No. 2 photoflood bulbs (or three No. 1 bulbs) are to be used, it might be well to provide for separate line cords; you'll be drawing over 20 amps! Keep in mind that household fuses are usually 15 amperes and a 20 ampere circuit is needed.

When using the unit, plug all lamps into place (with the individual bulb switches on "Dim"), set the "Lamp" switch, and plug the unit into an outlet before turning the "Power" switch on. Any or all lamps can then be turned to "Bright" by individual switches to adjust the lights, check exposure, focus, etc. Then turn the lamps back to "Dim" and let the subject relax. As soon as the exposure is made, reduce the glare by pressing the "Reset" button (if using a synchronized shutter) or releasing the "Solenoid Release" button, if using a solenoid.

If substantial use of the unit is contemplated, a larger size battery should be used, as the relay and solenoid drain is fairly heavy, and the relay action slows down as the battery ages.

Milt Kiver on Probes

Continued from page 110

(We are considering C1 and C2 as a single capacitor equal to the sum of their values.) If the probe capacitance is 10 mmfd and (C1 + C2) is 100 mmfd, the total capacitance becomes:

$$Ct = \frac{10 \times 100}{10 + 100} = \frac{1000}{110}$$

$$= 9.1 \text{ mmfd}$$

Thus, the input capacity of the oscilloscope and the low-capacity probe is reduced by a factor somewhat greater than 10. If, now, we also shunt Cp by a resistance which raises the total series input resistance to a value 10 times its former value, then we have increased this item by a factor of 10, as well. This is done by R1, in Fig. 6.

The lowered input capacitance and increased resistance is not obtained without a penalty, however. In this case, the signal reaching the oscilloscope input is reduced in the same proportion. Generally, however, the circuits where these probes are employed are high signal level circuits.

Low-capacity probes frequently employ a variable trimmer capacitor to enable the user to adjust the frequency characteristics of the probe to match the frequency compensating network at the scope input.

To obtain maximum usage from the low-capacity probe, the input attenuator of the oscilloscope must be frequency-compensated in each position of this switch. Most modern oscilloscopes have a satisfactorily constant input impedance on the X1, X10, X100, and X1000 positions.

EI Build-It Course-6

Continued from page 87

adding RF amplifier stages, but up go the cost and complexity. A *radical* increase in signal voltage on the control grid, with no sacrifice to the circuit's simplicity can be obtained.

Regeneration provides the answer. Recall that the plate circuit contains an amplified version (though still not strong enough) of the weak grid signal. If some of this voltage could be "stolen" and returned back to the grid, the original signal would be greatly reinforced.

The route of the feedback signal is shown in the full-page theory diagram. Trace it through and the derivation of the word "regenerative" should become apparent. The original signal is "generated over again."

Note that the screen grid of the tube is used as the feedback source, not the plate circuit as previously explained. The reason is mainly one of control. The screen grid attracts electrons by virtue of its high positive voltage. It's true that most electrons will fly through spaces in the screen on their way to the plate, but sufficient numbers flow through its wires to supply feedback. It is a simple matter to regulate the screen's positive charge by a potentiometer. An important advantage is that the screen current is small compared to plate current.

For the "tickler" (in the theory diagram) to feed back signals properly, its turns must be *phased*. This consists of winding its coil in the same direction on the coil form as the tuning coil. Otherwise its magnetic field will oppose—and *reduce* the voltage in the tuning coil. This is opposite to the desired effect of boosting the input signals (negative, rather than positive feedback).

Varying the voltage on the tube's screen grid controls the amount of feedback and, consequently, the gain of the tube. But—once the regeneration control is advanced beyond a critical point, the tube goes into oscillation. A sustained circulation of current travels from tuning coil to screen, feedback coil and back to the tuning coil. This adheres to a fundamental prerequisite for oscillators; when positive feedback is great enough to overcome resistances in the circuit, the stage self-oscillates. The frequency of the oscillation is determined by the coil and variable tuning capacitor.

Oscillation easily occurs with no external signals being received. Random electrons flowing in the tube can trigger it off.

With the tube in this condition, what happens when a received signal finds its way down the antenna and on to the control grid? It encounters the oscillation frequency and the two signals mix. It is the difference between the two that is heard in the earphones. This is the basis for code reception in the regenerative detector.

Construction of the regenerative detector may be done in one of two ways. It can be designed to be compatible with the other plug-in projects already described in this series, or operated solely in conjunction with a source of power. Voltages needed: 6.3 volts AC and 250 volts DC. The unit shown in the illustrations, as it is set up, will not physically fit into the space formerly occupied by the AM or FM tuner; a cable running to the power supply was used instead. However, with some modification it could be made to fit into place and not be an "outboard" unit. Use an 8-pin plug (same as PL7 in the Parts List) on the side of the chassis that goes to the receptacle on the preamplifier, and mount PL7 so it matches the receptacle on the power supply. Run a pair of leads between pins 6 and 8 on the two plugs to complete the AC primary switch connection. This is the reason pins 6 and 8 are jumped together on the outboard model. It serves to complete the power supply circuit.

Another change must be made for the full plug-in feature. The input and output terminals must be mounted on the top surface of the chassis.

While winding the coil, remember that the turns must be in the same direction, or the feedback will not be positive. One expedient is to hold the coil form in the left hand, with its prongs always pointing to the left as the turns are wound. As each winding is completed, make a hole in the plastic with a sharp instrument (at the end of the last turn), poke the wire through, and route it to its associated pin. Note that two of the coil leads will go to pin 4, and thus may run through the same hole in the coil form.

Keep the antenna fairly long, starting out with a length of wire about thirty feet long.

If dead spots occur as the tuning capacitor is rotated, the antenna coupling is probably not adjusted correctly. This may be changed in two ways. First, alter the spacing between the antenna winding (L3C) and the tuning coil (L3B). The amount of turns may be changed also.

Don't solder the coil wires to the pins in the coil form until the set is operating properly. As each winding is completed, scrape the enamel insulation on the wire, push it through its coil form pin, and bend it back. The coil may then be inserted into its socket with its wires making proper contact. If changes are necessary, they can be made rapidly, without the need for repeated soldering. Coil dope may be applied to the turns of wire to hold them in place.

The secret of obtaining good operation with this receiver is proper use of the regeneration control. For 'phone reception, the most sensitive point is just before oscillation occurs. Oscillation starts with a characteristic "click" which becomes a hissing sound as the control is advanced. When code stations are tuned in, the control should be set to the point where oscillation just begins.

SWL Antenna Tuner

Continued from page 42

for holding it in place securely. By turning the form counter-clockwise with your left hand you can guide the wire with your right. When the first five turns have been wound, stop and put a twist in the wire, forming an "eyelet." The second tap is 12 turns from the beginning, etc.

Coat the finished coil with dope and with razor blade, carefully scrape the enamel insulation off each coil tap. It is helpful to tin each one with a coating of solder. Drill two small 6-32 holes in each end of the form for mounting the form to the case. Wire the unit as shown in the drawings and photos.

The Fuel Cell

Continued from page 83

cations. "Peaking" is the major application for Bacon's "Hydrox" cell. The cells would help provide that "extra" electricity demanded of central power stations during peak periods. In off hours, the central stations would manufacture hydrogen and oxygen to fuel the cells.

The General Electric fuel cell requires only simple, compact controls and would be suitable for something as small as a portable television set. Since all fuel cells produce direct current, the TV set could be made without a rectifier circuit—just as though it were powered by conventional batteries.

The Allis-Chalmers fuel cell runs on air and propane. Any cell that can use air instead of expensive bottled oxygen has obvious advantages. An English competitor to the Hydrox cell known as the "carbox" cell also runs on air instead of oxygen. The other fuel component can be natural gas, manufactured gas, or vaporized kerosene.

The fuel cell does very well at steady, long-time jobs. Engineers with a leading American oil company have calculated that a 36-horsepower fuel cell could equal the performance of a 300-hp conventional engine in a car weighing as much as an Oldsmobile. DeSoto engineers have already made a model of a car powered by fuel cells. The electricity would feed an electric motor in each wheel. A four-wheel drive like this would offer very smooth acceleration.

Not only would no transmission be required, but the electric motors could be switched to act as generators, feeding the electricity generated by the braking action into a bank of resistors (which could heat the car)! Electric trains work on the same "dynamic braking" system.

One factor that would affect the rate of commercialization of the fuel cell is its competition. The strongest competition in the "no moving parts" category is thermoelectric generation (see "Thermoelectricity: A Look Into the Future," *Electronics Illustrated*, Sept. 1959).

Thermoelectric devices require heat to generate electricity. This means that thermoelectric generators could go into all sorts of waste-heat situations where the fuel cell does not apply.

Fuel cells are much more efficient than thermoelectric generators, running as high as 70 percent conversion of energy compared to a high of 10 percent for thermoelectricity.

In view of all the new ways of making electricity (don't forget the solar cell), it would be rash to predict that the fuel cell will be the star of the younger generation of power sources. With each new method finding its own best applications, there is little doubt that the fuel cell will gain an important place. *By E. M. Delman*

Tweeter Globe

Continued from page 32

trick here is to bend back the mounting flange lip of the speaker in order that the speaker can better accommodate the internal curvature of the globe. After the mounting holes have been laid out and drilled, the globe's rough paper edges of the cutouts and holes should be sanded smooth.

Sofar as impedance match is concerned, standard formulas for figuring impedance are employed. In this case, some surplus tweeters were used having a voice coil impedance of 3.2 ohms. A set of five and four were connected in series, giving an impedance string of 16 ohms and 12.8 ohms. These two strings were then connected in parallel, resulting in an approximate impedance figure of about 7 ohms. Any set of small cone tweeters will do. A reasonably priced unit is the Jensen P 35 VH ($4.00) or Lafayette SK100 (2 for $5.95—bracket must be removed). Consult the Olson Radio Warehouse or Allied Radio catalogs for others.

After the unit has been assembled and wired, the two halves are put together and the globe is mounted back on its stand. A ½" to 1" masking tape is used to bind the two halves together. If you desire to paint a new color, save tweeter cutouts to use as masks while painting with one of the popular aerosol spray cans.

All About Ham Nets

Continued from page 63

quested to stand by or move to another frequency while the net is in session."

He then invites net members to "report in," stating their location, any messages they have to send (or "traffic on the hook"). This "reporting in" may be at random, by alphabetical or prearranged order, or by roll call.

On CW nets the procedure is similar, except that abbreviations are used because it takes longer to say things via CW than by voice. The CW net control might send, for example: "PN (Podunk Net) PN PN DE (from) K2ABC K2ABC K2ABC QNN (net control station) QNZ (adjust your frequency to mine) QND (the net is directed) QNI (stations report into the net) QNA (by prearranged order) K (go ahead).

Long ago amateurs discovered that they could be useful in providing emergency communications during floods, fires, storms, and explosions which would wipe out telephone and telegraph lines, isolating communities. A ham or two in the stricken area would crank up their rigs from batteries or gasoline generators and establish a communication with the outside world. As this kind of thing became more frequent, the amateurs decided that it could be done more effectively if they were prepared and trained for it.

So about 25 years ago the ARRL organized the Amateur Radio Emergency Corps and encouraged amateurs to form local groups, prepare equipment, lay plans and conduct operator training for this specific purpose. Today there are about 1800 amateur Emergency Coordinators and over 40,000 amateurs "signed up" in the Emergency Corps.

Radio amateurs in this country can do something that amateurs in most countries are forbidden to do: handle messages for third parties. What kind of messages? Why, any kind at all, just so they don't get paid for it. They are usually written and handled in a standard amateur message form, not unlike the Western Union form. These messages are called "traffic," hence the nets that handle them are called "traffic nets." The idea is to get the message from its point of origin to its destination in the least possible time by passing it from one amateur to another.

Traffic nets are generally well organized and some of them are set up in "systems." One such system, sponsored by ARRL, is called the National Traffic System and consists of about 100 nets working together in chains covering the entire U.S., its possessions and Canada. In emergencies, these traffic nets and systems are often the means for handling important point-to-point traffic.

In a sense, the above nets are training nets. Whatever their primary purpose, a great part of it is in getting trained to do a job.

Newcomers to the amateur ranks via the Novice license *need* training, especially in Morse code. The Novice speed requirement is only five words per minute. You can't handle much communication at that speed, hence the purposes of many Novice nets are to increase code speed and teach net procedure.

Sometimes a group of amateurs with something in common will get together in a net. Doctors, dentists, religious groups, engineers, pilots, etc., have been known to form nets. A year or so ago a group of doctors formed a net to discuss latest medical developments. Teenagers discuss rock 'n roll, scouting, sports, television shows (real crazy, dad!). The YLs have their own nationwide fraternal organization, the Young Ladies Radio League (YLRL) and have a number of nets consisting strictly of members of their own sex (no men allowed), such as the Ironing Board Net, the Nylon Net and the Tangle Net.

A few groups operate just for the sheer pleasure of getting to know each other. Usually started quite spontaneously, they might call themselves the Gum-Beaters Net, the Idiots Net, or the Hot Air Net. No telling what you might hear them talking about.

Most nets are deliberately set up by responsible amateurs for a specific purpose, usually emergency preparedness or traffic handling. These hams are bent on doing something useful with their hobby.

TV Around the World

Continued from page 90

enough range to adjust the sweep frequency to either 50 or 60 cycles, so no real difficulty on this score.

The horizontal hold is more of a problem. In the American standard, each of the 30 frames scanned in a second has 525 horizontal scanning lines. The electron beam in the picture tube must make 15,750 (30 x 525) horizontal sweeps each second. The horizontal sweep frequency is nearly the same in the European and Russian systems.

The British and French standards are considerably different, however. A receiver designed for the American, European, or Russian standard could not be used for British or French transmissions.

In the British and French standards a bright point in a scene causes a large output from the transmitter, and a reduction in brightness from one point to the next causes a reduction in transmitter output. This natural sounding arrangement is called "positive modulation." Natural though it may sound, the American, European, and Russian standards do not use it. They have "negative modulation." An increase in scene brightness causes a decrease in transmitter output. If a receiver designed for the American, European, or Russian standard is tuned to a British or French transmission, it will produce a picture which becomes brighter where it ought to be darker, and vice versa.

Besides all this there are differences in the sound also, some use AM while we and others use FM.

Why, you may ask, don't all of the countries of the world get together on one standard? Britain began transmitting regularly scheduled programs before anyone else, using their present standard (see chart). They believe the quality of their pictures would not be improved substantially by a change. The 819-line French standard can give better pictures than any of the others, but it requires twice as wide a channel which means fewer TV stations. World-wide satellite TV broadcasts will force a change, but when will it come?

RCA Voltohmyst Kit

Continued from page 58

This model differs somewhat from other kit-packaged VTVM's. More components specifically designed for insertion into a printed circuit board are included; the filter capacitor, selenium rectifier and of most interest, the three calibrating potentiometers. Note in the photo how this item plugs into a series of holes in the printed board, thereby eliminating the usual wiring between nine lugs and the rest of the board.

The format of the step-by-step instructions yields another difference between this model and other kits. Instead of the customary booklet, one large sheet contains the construction data.

All steps in construction went smoothly, totaling about eight hours. A supplementary booklet urges the beginner to solder properly and suggests the use of fine sandpaper for cleaning the copper foil on the printed circuit board. Solder will flow much more readily on a shiny surface uncontaminated by oxides. Steel wool will serve as admirably as sandpaper.

Excessive heat applied to the precision resistors can radically change their value and upset the accuracy of the meter. Use a heat sink; pliers that grasp the lead between the resistor and the soldering iron. Hold them there several seconds while the joint cools.

The wired kit is calibrated with the assistance of the small battery used in the ohmmeter section of the instrument. It's a simple procedure if no error in assembly has occured. Rough calibration is done as soon as the unit has been completed, while more accurate settings are possible after the tubes have aged for two days. Have no qualm about leaving the unit on for that period of time. In a well-designed piece of equipment, the tubes last longer if left glowing than when periodically turned on and off.

Long a popular test instrument in its factory-wired version, the Voltohmyst should prove equally as durable in kit form. In our laboratory tests it proved simple to use and accurate. We rate it as a Good Buy. –

Brainy Man Builds Better Brains

Continued from page 103

built computer that can remember what it is taught and will try to make human-like decisions on a practical level. Pask is of the opinion that our complex industrial society requires semi-human machines capable of teaching humans intricacies of other semi-human machines.

Eucrates I and a special companion device called "The Teacher," can be set up to interview a job applicant or to teach skills such as operating radar equipment, typewriting, piloting aircraft, driving cars or playing a musical instrument. By asking a series of questions and outlining situations that may arise, the device, in effect, forces the interviewee or the student to make a decision. If the student makes a wrong decision, signs of electronic emotion—equivalent to bursting into tears—are displayed. The computer-teacher then eases up on the student.

Pask, whose talents range from painting in oils (a bedroom wall mural), to geology, medicine, psychology, music, logic and writing poetry, first became interested in electronics while studying the rusty, grotesque slag heaps and old machinery scattered around the deserted lead mines of Wales.

In 1950, Pask teamed with physicist Bobbie McKinnon Wood and set up their own business, Systems Research Ltd., which aims at bringing British and world automation up to the highest possible standards. Pask lives at Number 5, Jordan's Yard, just behind St. John's College, Cambridge, England.

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Radio-Powered Sky Station

Continued from page 30

for the electronic detection and transmitting units on board.

The received microwave energy can be efficiently converted to heat by any one of several high temperature heat exchange metals that are placed in a pipe-like waveguide, which is fed from the antenna. This is a key element of the propulsion system. When the platform is operating on microwave power, this heat exchanger performs the same function as the combustor section of a conventional gas turbine engine, which increases the work potential of the engine fluid by raising its temperature. In the combustor this is done by mixing fuel with air and burning the mixture. In the microwave heat exchanger, the same result is achieved by attenuating microwave energy, changing its form from electrical energy to thermal energy, and dissipating this heat directly to the working fluid which ultimately spins the turbine. A new Raytheon government-funded study (details still classified) is said to have conclusively licked the heat exchange problem.

The logical means to get take-off and climb power for the platform's rotor blades is to install a chemical engine in the propulsion system. The supplementary chemical engine would amount only to a fuel tank, burner and heat exchanger in parallel with the microwave heat exchanger.

Even in high winds capped by gusts up to 20 to 30 knots the chemical system could lift the platform. At low altitudes the greater air density provides a power advantage despite the fact that the rotors are geared to work best at high altitudes. The RAMP would climb to altitude in a spiral path.

The science fiction writers are hard-pressed to keep ahead of present-day scientists. Perhaps in the not too distant future we will have high efficiency Amplitron-type tubes mounted in sky stations all the while beaming power through space at the earth, providing electricity for cars, houses and factories without local wiring.

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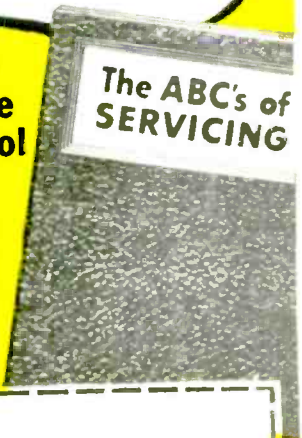

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